



FINAL REPORT

LOW-DENSITY PHENOLIC NYLON NOSECAP

SCOUT REENTRY HEATING PROGRAM

REENTRY E

FACILITY FORM 602

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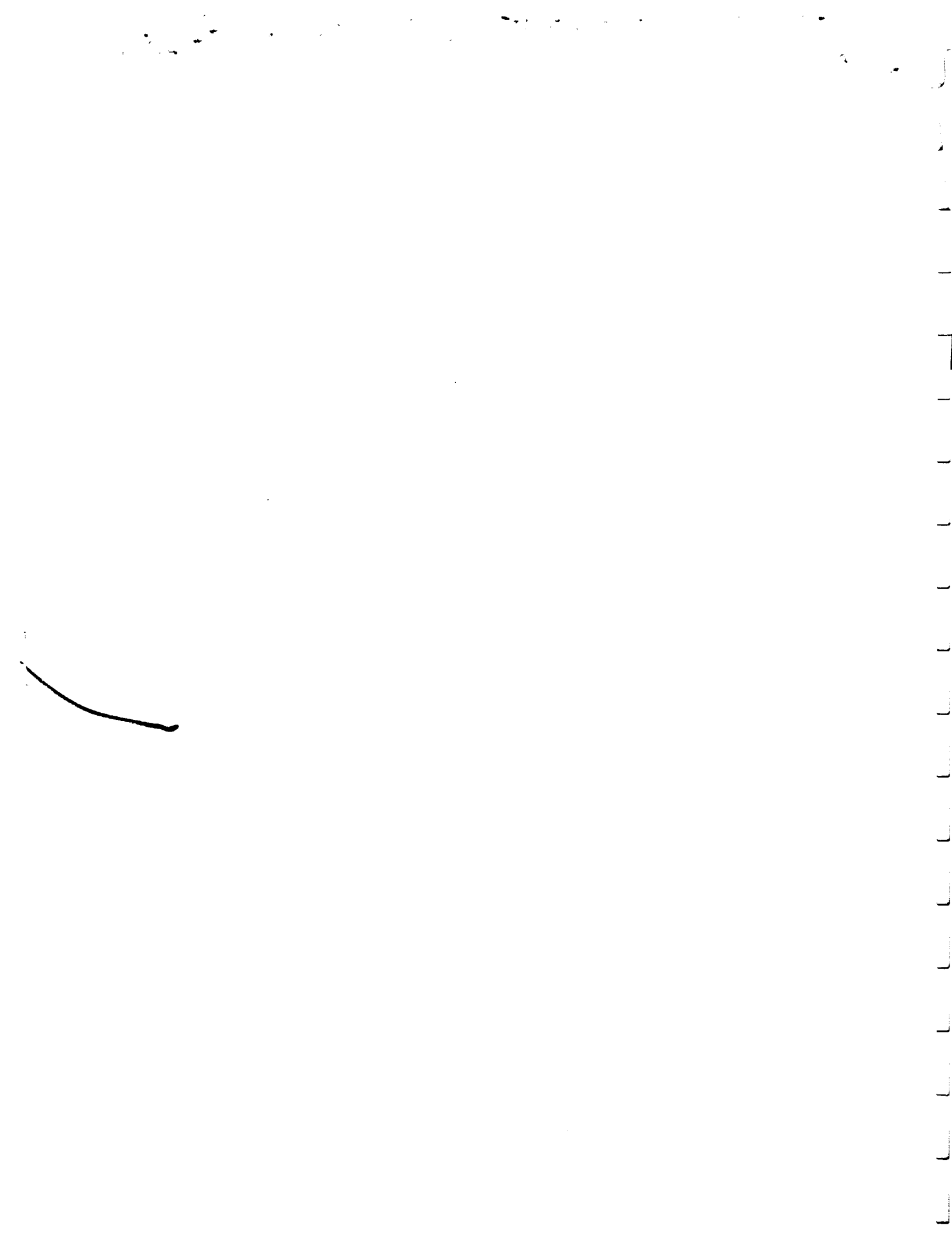
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This report describes the development, fabrication and assembly of two charring ablator nose caps for the Scout Re-entry E Project. Also, included is the detailed design and fabrication of the nose cap instrumentation.

The material which was chosen for the experiment is a low-density phenolic nylon charring ablator. The ablator composition is a mixture of phenolic resin, phenolic microballoons, and powdered nylon. In an effort to establish a predictable material behavior, various compositions of this material were subjected to ground tests. As a result of the ground tests, the exact material composition used for this experiment has demonstrated the capability of providing an ablator with char integrity, and a predictable surface recession rate. The characteristics of this ablator resin system, when correlated with reentry data, will provide a sound basis for predicting materials behavior during reentry environments.

*Author*

*ABSTRACT FOR NASI-4141-16*

*RR*



FINAL REPORT  
LOW-DENSITY PHENOLIC NYLON NOSECAP  
SCOUT REENTRY HEATING PROGRAM  
REENTRY

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(PHILCO)  
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Prepared for  
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION  
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Langley Station  
Hampton, Virginia



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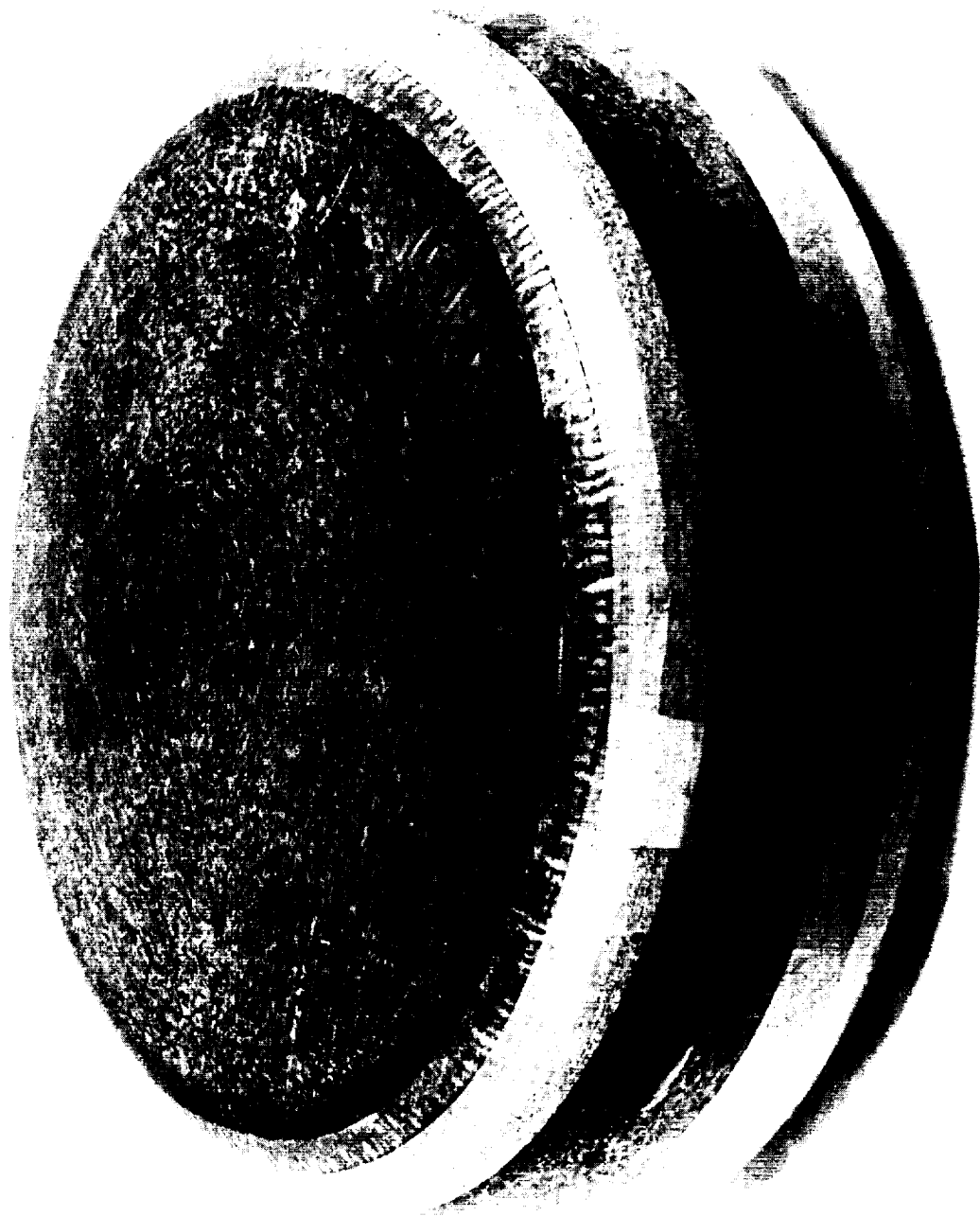


Figure 1. Reentry E Phenolic Nylon Ablative Nosecap  
with Moisture Barrier.



## INTRODUCTION

The Scout Reentry Heating Program consists of five models. Four models have been flown; the current model is an ablative materials experiment and is designated Reentry E. This report describes the development, fabrication, and assembly of two nose-caps for the Reentry E materials experiment. Nosecap No. 2 is the flight ready model and No. 1 is the backup.

A prerequisite for the Reentry E experiment was to select an ablative material for the nosecap which had been extensively tested in ground facilities and whose properties were sufficiently understood to make reasonable an extrapolation to the severe conditions of flight reentry.

The material which was chosen for the experiment is a low-density phenolic nylon charring ablator. The ablator composition is a mixture of phenolic resin, phenolic microballoons, and powdered nylon. In an effort to establish a predictable material behavior, various compositions of this material were subjected to ground tests. As a result of the ground tests, the exact material composition used for this experiment has demonstrated the capability of providing an ablator with char integrity, and a predictable surface recession rate. The characteristics of this ablator resin system, when correlated with reentry data, will provide a sound basis for predicting materials behavior during reentry environments.

Transducers, precisely located in the nosecap experiment, are used to provide a means of measuring the temperature and surface-recession rate of the ablator during reentry. Figure 1 illustrates the phenolic nylon nosecap with moisture protection.

## DESIGN

The spacecraft systems, figure 2, used in the Scout Reentry Heating Program, while similar in design, have variations in the nosecap depending on the particular experiment. In general, the spacecraft consists of a 9° blunt-cone configuration approximately 3-feet long, with a nose diameter of about 11 inches, and a base diameter of 20 inches. The ablator for this experiment, supported by a tungsten substructure which is used to secure the nosecap to the payload, has a spherically shaped surface with a 17.4-in. radius of curvature which is blended to the 9° cone.

## Reliability and Quality Assurance

The reliability and quality assurance plan for the Reentry E experiment, consisted of adherence to detailed fabrication procedures. These procedures were specifically generated for this ablative nosecap experiment and are included in the fabrication section of this report. Implementation of these procedures provided control in the areas of raw materials, fabrication, inspection, tests, and records.

A material review board consisting of project personnel was in force throughout the nosecap fabrication. The responsibilities of the review board included the control of nonconforming material and preliminary review action. In addition, the material review board controlled all drawing and procedural changes.

All material, parts, and components were procured in accordance with specifications established by the cognizant design engineer. The material specifications were recorded on the procurement documents.

A design review board consisting of nonproject personnel conducted reviews, as required, to evaluate the reliability criteria and to ensure prompt implementation of any changes that might be necessary.

Final verification of the reliability and quality assurance plan shall be ascertained when the nosecap-payload assembly and backup nosecap are subjected to the flight environmental test plan. This test plan requires the nosecap-payload assembly and the backup nosecap prototype assembly to be subjected to the expected flight environment, which includes shock, vibration, altitude, spin, and steady-state simulation. The nosecap payload and backup nosecap, upon successful completion of the flight test plan, will have satisfied all the requirements of the reliability and quality assurance plan.

## Ablator Material

To obtain a phenolic nylon ablative material with char integrity and a predictable surface-recession rate, a composition of 40-percent powdered nylon, 25-percent phenolic resin, and 35-percent phenolic microballoons was formulated. This composition, when molded in accordance with Molding Procedure 104, provided an ablator material with a density of 35  $\pm$  1 lb per cubic foot. When subjected to arc-jet tests, specimens of the ablator material satisfied the material requirements of this experiment based on analytical procedures.



The ablator material was then molded, in accordance with Procedure 104, into a 12-in. diameter billet 4-1/2-in. thick. After molding, the billet was subjected to radiographic inspection to determine whether any voids, porosity, or foreign material were present within the billet. The billet was then contoured on one side, to fit the substructure, in preparation for the bonding operation. The contouring of the ablator interface is shown in figure 3.



Figure 3. Ablator Interface Contour.

A 3.30-in. diameter disc (dwg No. LC-410120) was removed from the excess material contained in the billet prior to the contouring operation. This disc was then machined to provide three 1-1/2-in. diameter arc-jet specimens (dwg No. LB-410317). These specimens were then subjected to the arc-jet tests to verify that the material would perform in a manner comparable to material selected from previous arc-jet tests. After contouring of the interface area (dwg No. LC-410120), the billet was placed in a controlled environment of 70-percent  $\pm$  10 percent relative humidity and a temperature of 75° to +25°F to stabilize the ablator material. All subsequent fabrication processes utilizing the ablator material



were performed under controlled conditions to maintain material stabilization.

Bonding of the ablator material to the substructure was accomplished in accordance with Procedure 105 using a tape-supported adhesive, HT424. This adhesive is made by the Bloomingdale Rubber Company.

After the ablator had been bonded to the substructure, the outer spherical surface of the nose cap was contoured (dwg No. LC-410120). The conical sides and the blend radius were machined to conform to the experiment requirements. After this contouring operation, a moisture barrier was applied to the nose cap in accordance with Procedure 105. This moisture barrier is a covering of 0.003-in. teflon. The teflon, manufactured by Dow-Corning, is bonded to the nose cap with DC-274 adhesive, which cures at room temperature.

### Substructure

A tungsten alloy, Kennertium W-2, was chosen for the nose cap substructure to provide the spacecraft assembly with the required center of gravity. The substructure was contoured in accordance with dwg No. LC-410116, the axes were defined and inscribed on the nose cap mounting surface. As a reference indicator, thermocouple hole No. 19, contained in the vertical axis, was located nearest, and directly below, the inscribed legend "TOP". All holes required for installation of the sensors and mounting of the substructure were drilled prior to bonding of the ablator. This was done to allow a lubricant to be used during the substructure machining operation, in order to prevent the embedment of metal particles in the ablator material. All sensor installation holes were drilled with the hole axis normal to the outside contour of the substructure's spherical surface. The drilled substructure is shown in figure 4.

Helicoil inserts were placed in the sensor mounting holes to provide a positive method of securing the sensor mounting brackets to the substructure. The mounting washers for the thermocouples and light-pipe sensors (dwg No. LB-410124) were precision-ground at the time of sensor installation to ensure proper bottoming of the sensors in the ablator material. Shims (dwg No. LB-410123) were provided as required for installation of the spring-wire sensors. Bottoming of the sensors was accomplished with the use of the sensor mounting screws to apply a slight pressure on the sensor.

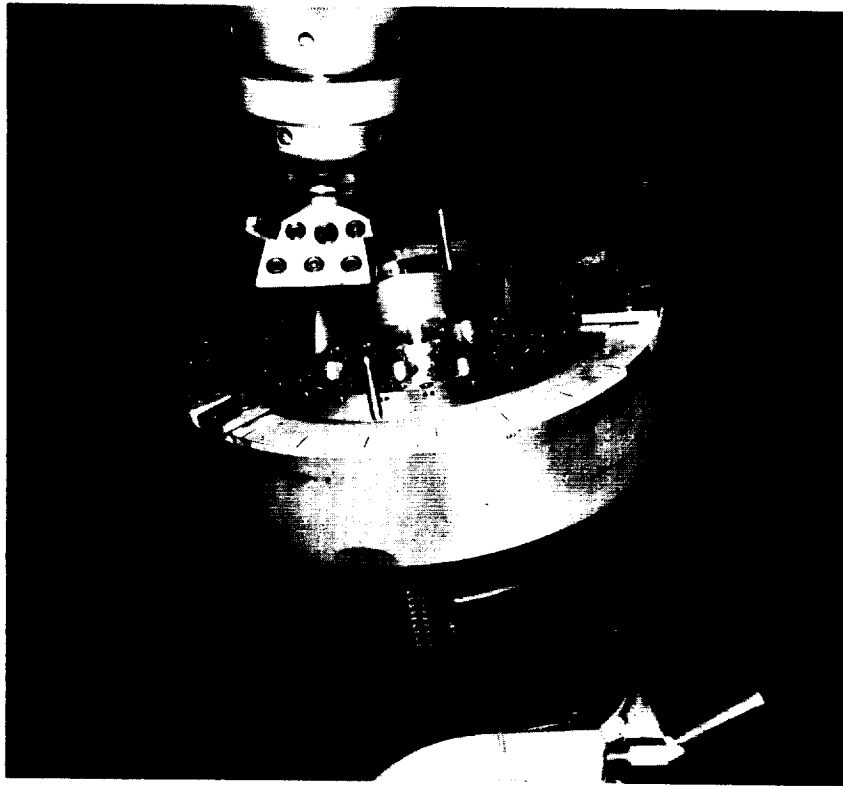


Figure 4. Drilled Tungsten Substructure.

#### INSTRUMENTATION

There are four types of sensors installed in the ablative nose cap. These sensors are used to measure the substructure temperature, the temperature of the ablator material, and the ablator surface-recession rate. These measurements are recorded during reentry of the experiment payload.

##### Substructure Temperature Sensors

Two thermistors were mounted directly on the rear surface of the tungsten substructure with RTV-102 sealant. One thermistor is mounted at the center of the substructure, and the other is mounted on an approximate 3-in. radius to provide temperature-monitoring of the rear surface area of the substructure (see dwg No. LX-410115).

## Thermocouple Sensors

To determine the temperature of the ablating material, 27 thermocoupler sensors (figure 5) were installed at various depths within the ablator. The thermocouples were mounted on three concentric circles, as shown on dwg. No. LX-410115. After installation of the 27 original thermocouple sensors was completed, it was decided to install two additional thermocouples to monitor the temperature of the ablating material in the area where the blend radius connects the spherical radius to the sides of the nose cap. The two new thermocouple sensors (T/C 46 and 47) were located as shown on dwg No. LX-410115. This increased the number of thermocouple sensors to a total of 29.

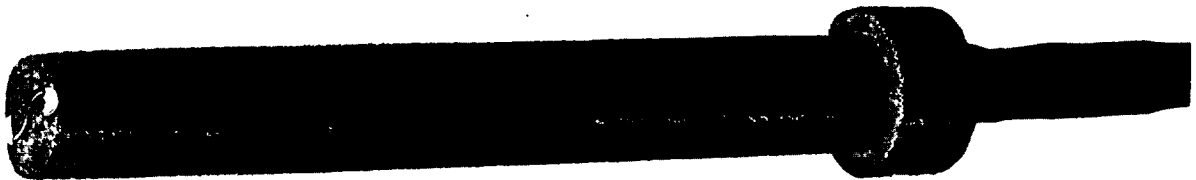


Figure 5. Thermocouple Sensor.

The thermocouple assembly (dwg No. LD-410117) consists of a 36-gage resistance lap-weld chromel-alumel hot junction which provides accurate temperature indications in the ablative material. The lap weld is centered on a 1/4-in. diameter plug of ablative material. The 36-gage wires run across the end of the plug, which is an isothermal plane, in order to minimize error in the thermocouple indication due to conduction down the leads. The 36-gage wires are inserted in quartz tubing that is bonded with Shell Epon 931 in grooves placed on each side of the thermocouple plug. The quartz tubing insulates the thermocouple wires in the radial direction. To provide flexural strength for the lead wires during handling, 30-gage chromel-alumel lead wires are resistance-welded to the 36-gage wires directly behind the quartz tubing. These

wires are bonded with Shell Epon 931 in the plug grooves. A cap of ablation material is also bonded to the rear-end of the plug to secure the sensor leads. The thermocouple sensors were fabricated and tested in accordance with Procedure 103.

#### Light Pipe Ablation Sensors

The light pipe ablation sensor (figure 6) is designed to measure ablator surface position and, when correlated with time, to provide the surface recession rate. Four light pipe sensors are embedded at various depths within the ablative material. The light pipe sensor utilizes a high melting-point sapphire optical fiber to channel the light present at the surface of the ablating material through an infrared filter to a photosensitive diode. A predetermined diode resistance level, selected experimentally, is used to correlate surface position with time.

The light pipe sensor assembly (dwg No. LD-410118) consists of a 0.016-in. diameter sapphire rod inserted into a thru-hole in a 1/4-in. diameter plug composed of ablative material. An infrared filter, 0.082-in. diameter, is inserted into the hole from the rear of the plug and positioned flush with the sapphire rod. The photosensitive diode, with shielded leads, is bottomed against the filter. The rear of the sensor plug is filled with an epoxy resin consisting of 60-percent CIBA 6005 and 40-percent Versamid 140, which encapsulates the diode and lead wires within the plug. The light pipe sensors were fabricated and tested in accordance with Procedure 102.



Figure 6. Light Pipe Ablation Sensor.

### Spring Wire Ablation Sensors

The spring wire sensors (figure 7) were designed to obtain a measurement of the ablating material surface position which is correlated with time to yield surface recession rates. Twelve spring wire sensors are embedded at various depths within the ablator. The sensors are located on two concentric circles, as shown in dwg No. LX-410115.

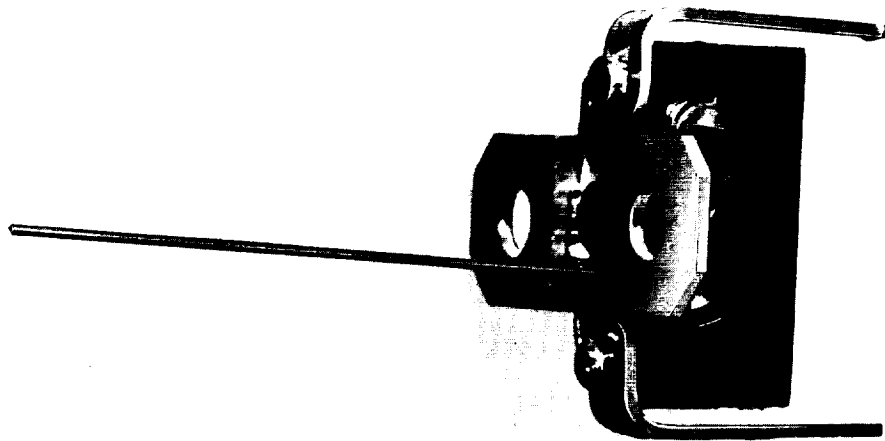


Figure 7. Spring Wire Ablation Sensor.

The spring wire sensor consists of a 0.020-in. outside-diameter metal tube attached to a snap-action microswitch. A 0.003-in. diameter tungsten wire, knotted at one end, is secured to the end of the tubing, which has been spun closed and drilled to a 0.004-in. diameter hole. The wire is threaded through the tubing and attached to the leaf spring of the switch so as to hold the spring under tension. The tubing is then embedded in the ablation material to the desired depth. As the nosecap material ablates to the location of the sensor, the very steep temperature gradient at and just below the surface softens the tubing and releases the wire, allowing the microswitch to close.

The choice of material for the support tube is dictated by the expected surface temperature of the ablator. For the Reentry E experiment, molybdenum (melting temperature approximately 4700°F) was selected for the support tube, and 0.003-in. diameter tungsten wire for the spring wire. The spring wire sensor assembly is shown on dwg No. LD 410119. The sensors were assembled according to Procedure 101.

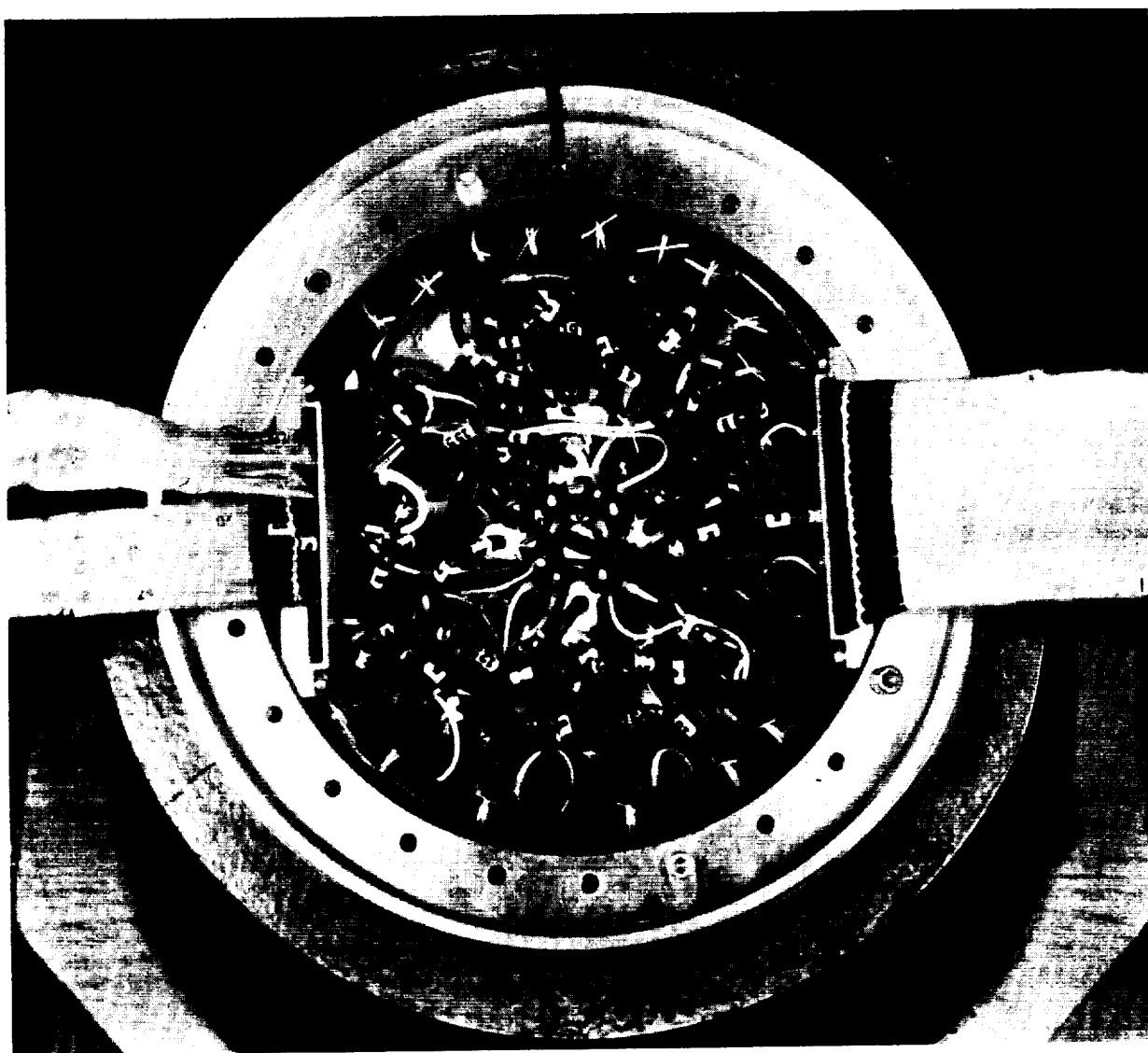


Figure 8. Nosecap Assembly with Sensing Devices.

## INSTRUMENTATION INSTALLATION

The low-density phenolic nylon nose-cap subassembly was supported during installation of the sensing devices to prevent damage to the ablator surface. A number of transducers are located within 0.200 in. of the forward face of the ablator; therefore, to prevent shearing of the ablator material upon insertion of the sensing devices a backup support surface was required. This support was fabricated by the use of quick-setting plaster molded to the nose-cap spherical surface. The ablator material was protected from the plaster by a 0.003-in. layer of teflon. All sensors were installed in the nose-cap assembly in accordance with Procedure 106. Thermocouple location hole No. 19 is adjacent to the reference point "TOP", which is inscribed on the substructure as previously described.

The spring wire ablation sensors were installed in the nose-cap assembly first, to avoid interference with other instrumentation lead wires. Nonmetallic shims are used to position the spring wire sensors within the ablator at precise depths and to prevent the sensor terminals from making electrical contact with the substructure. A shim was selected for a sensor by first measuring the depth of the hole in the ablator as well as the length of the sensor probe. Then the thickness required was computed, and the shim was machined to this dimension. The shim was placed under the mounting bracket, and the tube assembly inserted into the ablator. The mounting bracket of the sensor was secured to the substructure with mounting screws.

The thermocouple sensor assembly utilizes precision-ground washers, individually machined for each thermocouple assembly by measuring hole depth and sensor length, to assure proper bottoming of the sensor with the ablator at a specific location. Prior to insertion of the thermocouple assembly in the ablator, a thin coating of epoxy bonding agent (60-percent CIBA 6005, 40-percent Versamid 140) was applied to the sides of the thermocouple assembly plug, from the shoulder to the face end. No adhesive was applied to the face area of the thermocouple assembly. Then the sensor was inserted into the ablator and the precision retaining washer was properly positioned and secured to the substructure with mounting screws. A small amount of RTV-60 was applied to the back of the washer to support the wiring as it passes through the washer.

The light pipe sensors were installed using precision-ground washers to assure proper bottoming of the sensor within the ablator at a specific location. A thin coating of epoxy bonding agent (60-percent CIBA 6005, 40-percent Versamid 140) was applied to the sides of the sensor from the shoulder to the sensor face end prior to insertion of the sensor into the ablator. No adhesive was

applied to the face area of the light pipe sensors. The sensor was then inserted into the ablator. The precision-ground washer was properly positioned and secured to the substructure with mounting screws. A small amount of RTV-60 was applied to the back of the washer to support the wiring as it passes through the washer. Any void between the structure and the shoulder of the light pipe sensor was filled with Epon 931. Figure 8 shows the nose cap assembly with all sensing devices installed.

Two thermistors to monitor the tungsten alloy substructure temperature were bonded to the surface of the substructure with RTV-102 sealant, as described in Procedure 106.

The common lead-wire connections were completed, the lead-wires were color-coded, and the leads were dressed and secured with cable clamps. The nose cap was then X-rayed and inspected for voids. Next, the sensor leads were wired to the connectors as indicated in table 1.

Figure 9 shows the location of thermocouple mounting holes No. 46 and No. 47. These two thermocouples were added after the nose caps were instrumented and are used to monitor the temperature at the 9° blend radius of the nose cap. Figure 9 (sheet 2) shows the thermocouple installed in location hole No. 46.



Table 1. Connector and Sensor Lead Connections

Connector	Sensor	Pin No.	Connector	Sensor	Pin No.
P610	SW 30	1	P611	TC 3	1-2
	31	2		4	3-4
	32	3		5	5-6
	33	4		6	7-8
	34	5		7	9-10
	35	6		8	11-12
	36	7		9	13-14
	37	8		10	15-16
	38	9		11	Spare
	39	10		12	19-20
	40	11		13	17-18
	41	12		14	21-22
	SW Common	13		15	23-24
	LP 42	14		16	25-26
	43	15		17	27-28
	44	16		18	29-30
	45	17		19	31-32
	LP Common	18		26	33-34
		19 (Spare)		Thermistor	35-37
					36 (Spare)
P612	TC 46	1-2	P	Thermistor-disconnect	
	20	Spare		Thermistor	A-B
	21	3-4		1	
	22	5-6		Thermistor	C-D
	23	7-8		2	
	24	9-10			
	25	11-12			
	27	13-14			
	28	15-16			
	29	Spare			
	47	19-16			
	Thermistor	17-18	Note: For TC pins, even number pins negative, odd number pins positive		

After the sensor leads were wired to the connectors (dwg No. LL-604108 and LC-603899), a resistance measurement was made of each sensor to assure satisfactory operation. These measurements were recorded on the sensor log, forms RE1, RE2-1, RE3, and RE4.

A polystyrene compound, Isofoam PE-2, was then applied to the instrumentation area of the nose cap assembly to completely encapsulate the sensors. When the encapsulant had completely cured, a resistance check of all the sensors was again performed to make sure that all sensors were functioning properly.

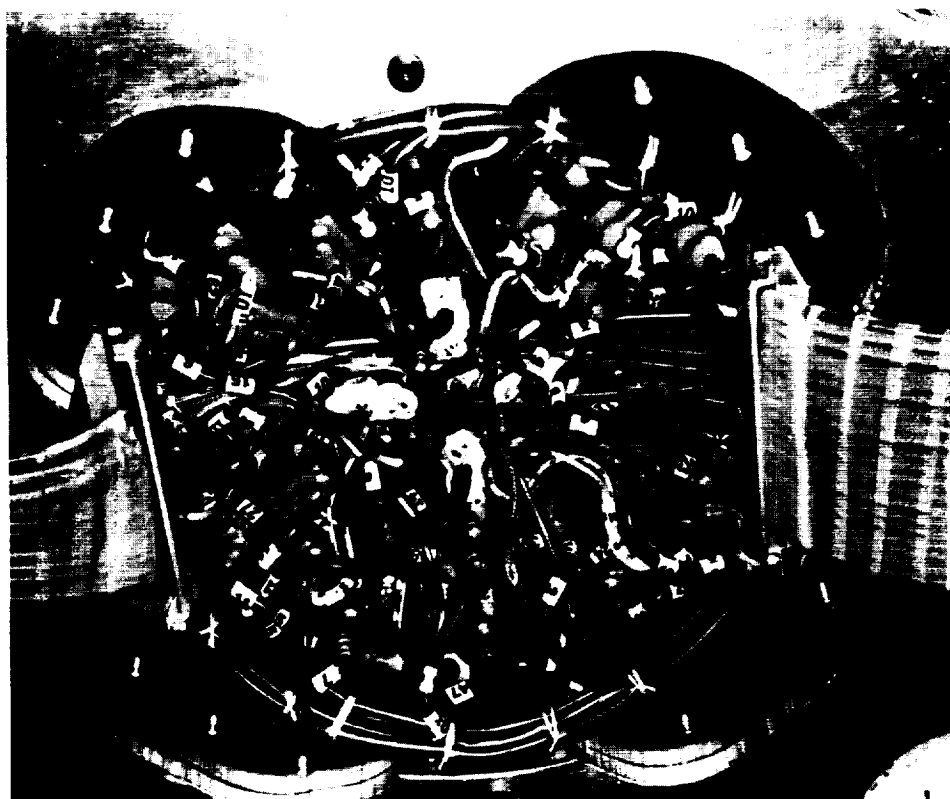


Figure 9. Location of Thermocouples No. 46 and  
No. 47 (Sheet 1 of 2)

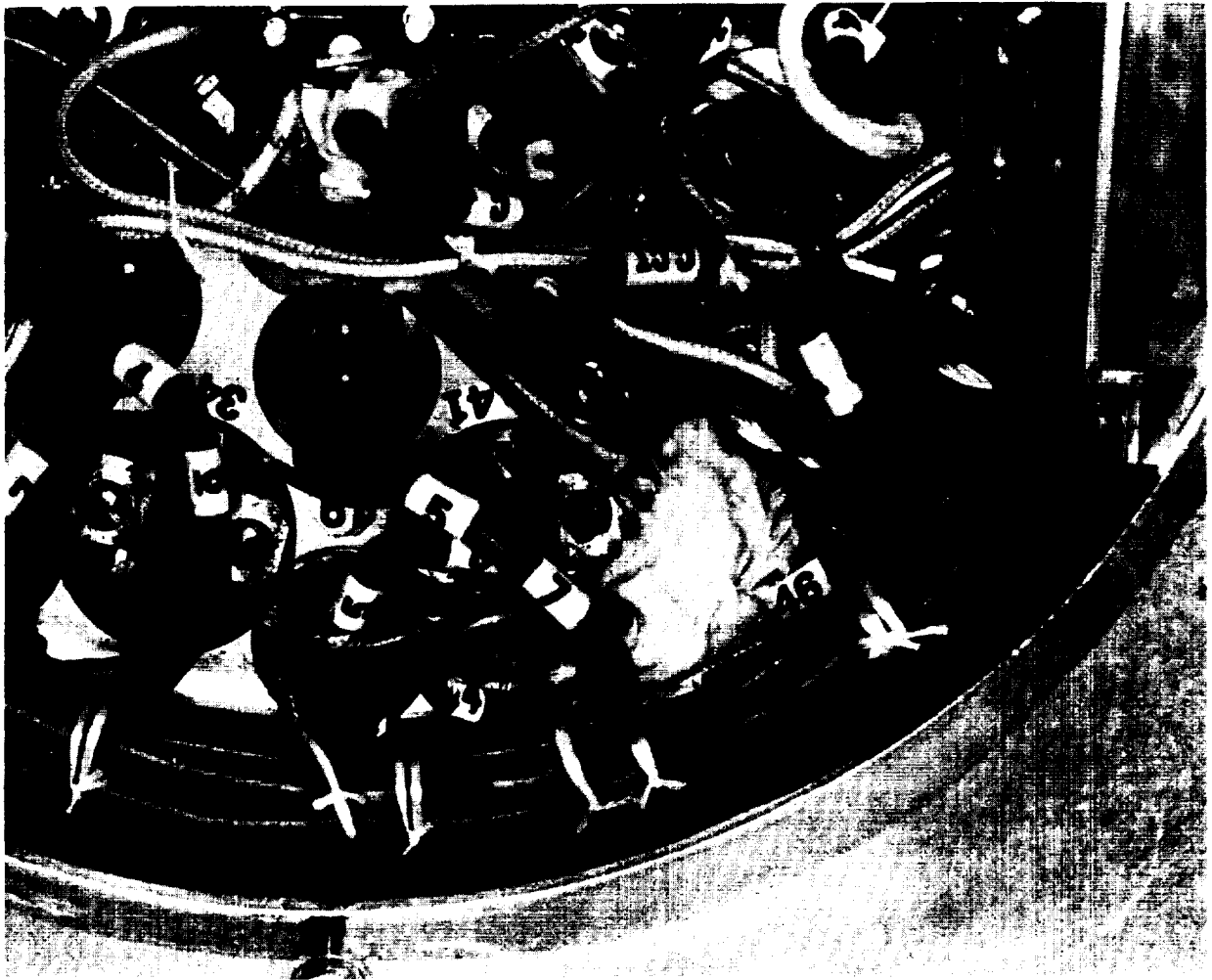


Figure 9. Location of Thermocouple No. 46  
(Sheet 2 of 2)



## FABRICATION AND TEST PROCEDURES

## FABRICATION AND TEST PROCEDURES

The following procedures have been developed for the Scout Reentry Heating Project Reentry E materials experiment. These procedures provide detailed guidance in component fabrication, testing, and assembly of the low-density phenolic nylon ablative nose cap.

Procedures	Page
Spring Wire Ablation Sensor, Procedure 101	19
Light Pipe Ablation Sensor, Procedure 102	27
Thermocouple Sensor, Procedure 103	35
Ablator Molding, Procedure 104	47
Bonding, Procedure 105	71
Nosecap Instrumentation, Procedure 106	79
Arc-Jet Test, Procedure 107	95

## SPRING WIRE ABLATION SENSOR

### PROCEDURE 101

#### Spring Wire Ablation Sensor Assembly

The procedural steps required to fabricate the spring wire ablation sensor are given below.

##### 1. Reference Drawings:

- (a) Detailed assembly (dwg No. LD-410119) figure 12
- (b) Locating jig (dwg No. LA-410333)

##### 2. Material Required:

- (a) Microswitch 1SM1
- (b) Molybdenum tube, assembly drawing, detail b
- (c) Stainless steel tubing, 0.015 in. OD X 0.011 in. ID
- (d) Wire, 99.7 percent tungsten, hard drawn, fine grained; 0.003 in. diam., minimum tensile strength 400,000 psi, cleaned
- (e) Switch cap, assembly drawing, detail d
- (f) Mounting bracket, assembly drawing, detail a
- (g) Wiring lug, assembly drawing, detail c
- (h) RTV 102 sealant
- (i) Duco cement
- (j) 100K, 1/10 W, 5 percent carbon resistor

##### 3. Fabrication and Test Equipment Required:

- (a) Eye loupe, approximately 3X
- (b) Simpson VOM, Model 262
- (c) Spring tension gage, graduated from 50-250 grams
- (d) 0.025-in. feeler gage
- (e) 0.060-in. feeler gage
- (f) Die plate, 1/16-in. thick
- (g) Resistance welder, Unitek Weldmatic, Model 1016
- (h) Shop microscope with eyepiece calibrated in thousandths
- (i) Location jig

#### Assembly and Inspection Procedure

1. Remove original cover from microswitch at glue line by cracking and chipping cover. Next, remove a sufficient amount of the switch shoulder opposite the brass support plate to provide an optical sighting port for the contact leaf spring.
2. Clean retaining shoulder of microswitch until free of cement, residue and remaining pieces of cover.

3. Visually inspect microswitch to ensure that contact leaf spring of switch is free of damage and centrally aligned.
4. Remove the raised letters from the base of the microswitch to provide a flat measuring reference point.
5. On the solder lug side of the microswitch base, using the location jig shown on dwg No. LA-410333, drill a 0.020-in. diameter (No. 76 drill) hole to a depth of 0.150-in. Measure actual depth of hole and record on fabrication log, form RE2-1, figure 10.

#### CAUTION

Provide backup support for the contact leaf spring while drilling to prevent damage.

6. Drill a 0.0135-in. diameter (No. 80 drill) hole, centered in the 0.020-in. diameter hole previously drilled, through the switch base, the brass support plate, and the contact leaf spring.
7. Remove all burrs from the brass support plate and contact leaf spring after drilling.
8. Thread a knotted wire through the contact leaf spring and switch so that the tension in the spring can be measured at the location of the 0.0135-in. hole. Pulling on wire will depress switch; releasing wire will return switch to its normal position. The releasing tension is critical and must be at least 100 grams. Measure this tension with a tension gage, and record the result on the log, form RE2-1. If below 100 grams, the tension may be increased by depressing the brass support plate.
9. Travel is the distance which the wire will move from the fully depressed position of the spring to the point where the switch snaps back to its normal position. This travel shall be a minimum of 0.013 in. Measure and record the travel on form RE2-1.
10. Using a 0.060-in. feeler gage, adjust the outer contact so that the gap between contacts is 0.060 in.
11. Assign a serial number to the switch, and record the number on the fabrication log, form RE2-1.
12. Visually inspect the microswitch after drilling and make the following observations:
  - (a) Microswitch shall be free of dust and filings.
  - (b) Hole in brass support plate and contact leaf spring shall be free of burrs.



13. Select finished molybdenum tubing as shown on assembly dwg No. LD-410119, detail b. Measure and record the actual tubing length.
14. Press the tubing into the 0.020-in. diameter hole in the switch base until it is bottomed in the hole. Measure the remaining length of the tubing from the solder lug side of the switch base to ensure that the tube is bottomed; then record this length on the log.
15. Cut the 0.003-in. diameter tungsten wire to a length of 4 inches. Tie a simple knot in one end of the wire, and draw the wire through a 0.004-in. hole in a tempered steel die plate to set knot firmly. Use a tension of 600 grams to avoid stressing wire.
16. Visually inspect the wire and knot for damage using the eye loupe.
17. Thread the free end of the wire through the molybdenum tube, switch base, support plate, and leaf spring.
18. Slide a piece of stainless steel tubing onto the free end of the wire. Position the tubing close to the leaf spring. Crimp tubing to the wire.
19. Depress the contact leaf spring to the brass support plate, taking care to permit 0.002 to 0.005-in. clearance between spring and plate. Pull the wire taut, so that the knotted end is against the molybdenum tube. Holding the wire taut with a force of 200 grams, slide the crimped tube against the depressed leaf spring.
20. Adjust the dial setting of the resistance welder to 1.5-2.0 watt-seconds. Using copper electrodes, prepare a weld schedule for the tungsten wire and stainless steel tubing before making the actual weld.
21. With the wire held taut with 200 grams tension as in step 19, weld the crimped tubing to the wire. Trim excessive wire and tubing close to the weld junction to eliminate the possibility of interference with the action of the switch. Make a second weld to ensure that the tubing is securely fastened to the wire.
22. Visually inspect the assembly and make the following observations:
  - (a) Using an eye loupe, check the knot in the tungsten wire for damage.
  - (b) Using an eye loupe, inspect the weld for excessive burning.

- (c) Using a nonabrasive probe, apply just enough pressure on the leaf spring to open the contacts. Repeat this operation several times to assure that the crimped tubing is securely fastened to the wire.
  - (d) Measure the clearance between the contact leaf spring and brass support plate with a shop microscope having an eyepiece calibrated in thousandths of an inch. This clearance shall be 0.002 to 0.005 in. Record the actual clearance on the fabrication log, form RE2-1.
  - (e) Record the results of these inspections on the log.
- 23. Cement a bakelite switch cap onto the microswitch, using a minimum of Duco cement and taking care to avoid having cement run into the microswitch.
  - 24. Attach two mounting brackets to the assembly with appropriate hardware, as shown on the assembly drawing.
  - 25. Bend wiring lugs to the profile shown in the assembly drawing, and fit the lugs to the switch solder terminals.
  - 26. Attach a 100K, 1/10-watt resistor between the solder terminals. Soft-solder the lug and resistor lead to the terminal. Inspect the solder connections and record the results on the log, form RE2-1.
  - 27. Using red paint, mark a dot on the top of the switch cover to indicate the common terminal or side of the switch. Refer to the assembly drawing.
  - 28. Using a Simpson Model 262 VOM, perform a continuity check between the wiring lugs. The sensor resistance shall be 100K  $\pm$  10K. Record the actual resistance on the log.
  - 29. Inspect the switch cover. The seam shall be free of excess cement.
  - 30. At the time of installation of the spring wire ablation sensor in the nosecap, record all pertinent data on installation log, form RE2-2, figure 11.

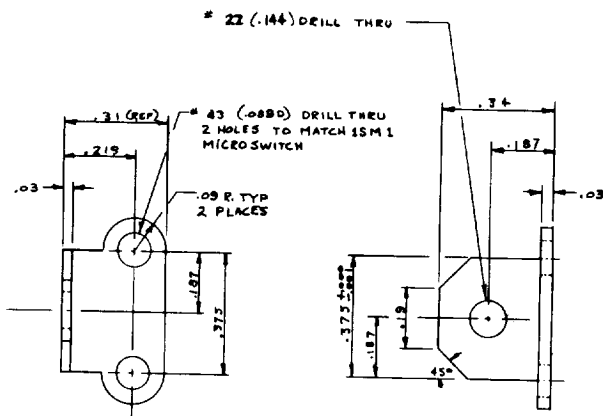
[illegible]

### Figure 10. Spring-Wire Ablation Sensor Fabrication Log

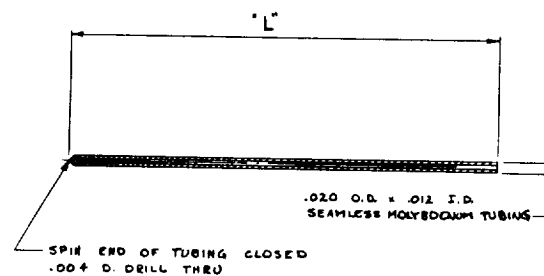
SPRING WIRE ABLATION SENSOR INSTALLATION LOG							Installed		
NOSECAP NO.							Date:		
Sensor number	Sensor Length		Hole number	Total thickness of nosecap	Hole depth	Remaining thickness	Shim thickness	Distance from surface to end of tube	Hole number
	To end of tube	To end of knot							

Form RE2-2

Figure 11. Spring Wire Ablation Sensor Installation Log.

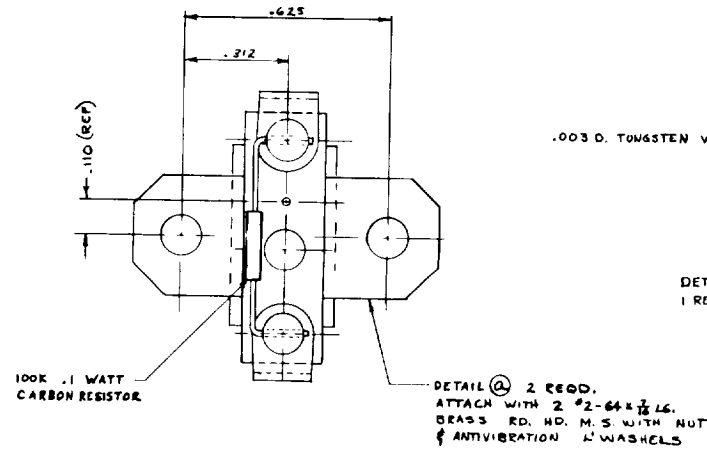


DETAIL A  
MOUNTING BRKT.  
MATERIAL: 2024-T4 ALUM ALLOY



DETAIL B  
PROBE  
MATERIAL: NOTED

DRAWING NO.	'Y'	'L'	TOTAL REQD
LD-410119-1	1.48	1.762	4
-2	1.38	1.662	4
-3	1.29	1.562	4
-4	1.19	1.462	4
-5	1.09	1.362	2
-6	.94	1.212	2
-7	.79	1.062	2
-8	.59	.862	2
-9	1.59	1.862	2
-10	1.14	1.412	2
-11	1.04	1.312	2
-12	.99	1.262	2
-13	.89	1.162	2



DET  
I RE









## LIGHT PIPE ABLATION SENSOR

### PROCEDURE 102

#### Light Pipe Ablation Sensor Assembly

The light pipe ablation sensor can be fabricated using the procedural steps given below.

1. Reference Drawings:

- (a) Detail assembly (dwg No. LD-410118) figure 15

2. Material Required:

- (a) Ablator plug, drawing detail c
- (b) Sapphire light pipe, drawing detail a
- (c) Infrared filter, drawing detail b
- (d) Diode, Texas Instrument part No. LS-400
- (e) CIBA 6005, epoxy (Araldite)
- (f) Versamid 140, reactive resin
- (g) 0.010 in. ID teflon sleeving
- (h) 1/64 in. ID teflon sleeving
- (i) Shielded lead wire, CIMCO type H-28-6736 SGT

3. Fabrication and Test Equipment Required:

- (a) Variac, 0-140 VAC
- (b) Transformer, 7.5 V filament
- (c) Tungsten light source, American Optical Co., Model 350
- (d) Achromatic Condenser, American Optical Co., part No. C235 or C236
- (e) VOM, Simpson Model 282
- (f) Precision micrometer
- (g) Microscope, 20X

#### Fabrication and Inspection Procedure

Note that all of the following operations are to be carried out in an environment where the relative humidity is controlled at 60  $\pm$  10 percent. The completed sensors shall be stored in this environment. The steps are as follows:

1. Record the ablator material control number on the fabrication log, form RE3-1, figure 13.
2. Machine the ablation material in accordance with the detail assembly drawing. Record the plug length and the actual diameter measured at the 0.248-in. plug dimension on the fabrication log. Procure serial number for sensor, tag plug, and record number on the fabrication log, form RE3-1.

3. Using a filtered, moisture-free air line, direct a stream of air through the 0.187-in. diameter hole from the 0.375-in. diameter end of the ablation plug until the plug is free of dust particles.
4. Visually inspect the ablation plug; it shall be free of chips, cracks, and dust.
5. Use standard optical procedures to cut and polish the sapphire rod in accordance with dwg No. LD-410118, detail "a". Ultrasonically clean the rods after polishing. Using a microscope, inspect ends of rods for any defects. Measure and record the length of the light pipe on the fabrication log.
6. Insert one end of the sapphire rod into the 0.016-in. diameter hole of the ablation plug at the 0.248-in. diameter end. Use a slight rotating motion.
7. Place free end of the sapphire rod on a firm surface. Carefully slide the ablation plug down over the rod until the rod is flush with the 0.248-in. diameter surface of the plug.
8. Looking at a light source, through the rod from the 0.375-in. diameter end, a round hole 0.016-in. diameter should be visible. If the hole is not round, distortion is present, indicating that either the light pipe is chipped or the light pipe hole is not properly aligned with the 0.082-in. diameter hole. Reject either the ablator plug or the light pipe or both.
9. Prepare the infrared filter in accordance with LRC dwg No. LD-410118, detail "b". Measure the diameter and length of the filter and record on the fabrication log. Insert the filter into the ablation plug through the 0.187-in. diameter hole. Make sure the filter is bottomed in the 0.082-in. diameter hole.
10. Again, look at a light source, through the filter and the rod to insure that no dust is obstructing the light. The light will have a slightly hazy appearance.

#### CAUTION

Exercise care while handling the diode; the diode leads are brittle and any flexing may cause the leads to break.

11. Measure the diameter of the diode and record on the fabrication log. In cases where there is excessive paint on the diode body, it may be removed by slight sanding.

#### NOTE

DO NOT REMOVE THE RED DOT.

12. Bottom the diode against the filter in the 0.082-in. diameter hole in the ablator plug. Using the test setup of LRC dwg No. LD-410118, adjust the position of the light pipe assembly until a maximum current indication is noted on the milliammeter. Record the maximum current on the log, form RE3-1. It must be between 18 and 24 milliamperes (ma.). If the maximum current indication is below 18 ma., reject the diode; if above 24 ma., buff the front end of the diode with fine sandpaper sufficiently to make the maximum current fall within the proper range.
13. Cut the diode leads and insulate with color-coded teflon sleeving in accordance with LRC dwg No. LD-410118. Solder the 4-foot lengths of lead wires to the diode leads.
14. Visually inspect the solder connections for evidence of a poor or cold solder joint. Cover one of the connections with color-coded teflon sleeving.
15. Using epoxy resin prepared in accordance with note 3 of LRC dwg No. LD-410118, pot the connection and diode lead wire up to the back end of the detector; then completely fill the cavity behind the diode in the ablator plug, using a fine stick or toothpick to apply the resin. Add small amounts of resin at a time to avoid trapping air bubbles in the plug.

#### NOTE

Before mixing, the epoxy and resin may be warmed to 115°F, if necessary, to reduce the viscosity and make the mixture more workable.

16. After the epoxy has cured for 16 hours at room temperature, recheck the maximum current output of the sensor, using the procedure outlined in step 12, above. Record the maximum current on the log, form RE3-1. If this reading is more than 2 ma. different from the reading taken in step 12, make a note to this effect in the remarks column of form RE3-1.
17. Using a Simpson Model 262 volt-ohm-milliammeter (VOM) on the 10K scale, with the positive terminal of the VOM connected to the positive (red) sensor lead, read the diode resistance and record this reading on the log, form RE3-1.
18. X-ray the sensor for voids in the potting and kinks in the wire, and attach the X-ray positive to form RE3-1.
19. Store the completed sensor in a plastic bag attached to the log, form RE3-1.

20. Periodic current and resistance checks are to be made on the sensor prior to installation in the nose cap and the results recorded on form RE3-1. Whenever resistance is measured, the Model 262 VOM must be used. During installation of the light pipe ablation sensors in the nose cap all pertinent data is to be recorded on the installation log, form RE3-2, figure 14.

LIGHT PIPE ABLATION SENSOR	FABRICATION LOG
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9
10	10
11	11
12	12
13	13
14	14
15	15
16	16
17	17
18	18
19	19
20	20
21	21
22	22
23	23
24	24
25	25
26	26
27	27
28	28
29	29
30	30
31	31
32	32
33	33
34	34
35	35
36	36
37	37
38	38
39	39
40	40
41	41
42	42
43	43
44	44
45	45
46	46
47	47
48	48
49	49
50	50
51	51
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66	66
67	67
68	68
69	69
70	70
71	71
72	72
73	73
74	74
75	75
76	76
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78	78
79	79
80	80
81	81
82	82
83	83
84	84
85	85
86	86
87	87
88	88
89	89
90	90
91	91
92	92
93	93
94	94
95	95
96	96
97	97
98	98
99	99
100	100

[illegible]

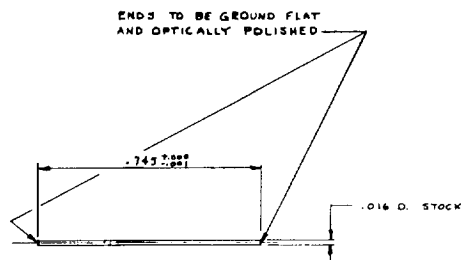
1954

**Figure 13. Light-Pipe Ablation  
Sensor Fabrication Log**

LIGHT PIPE ABLATION SENSOR INSTALLATION										Installed	
NOSECAP NO.										Date:	
Light pipe					Assembly (Mat'l No. )			Washer	Sensor resistance		
Serial number	Mat'l No.	L length measured	M length measured	Diam. meas.	Hole No.	Diam. meas.	Depth meas.	"X"	Shim thickness	Pre-installation	Post-installation

Form RE3-2

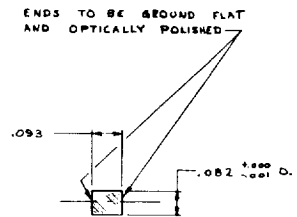
Figure 14. Light Pipe Ablation Sensor Installation Log.



DETAIL (a)

OPTICAL LIGHT PIPE

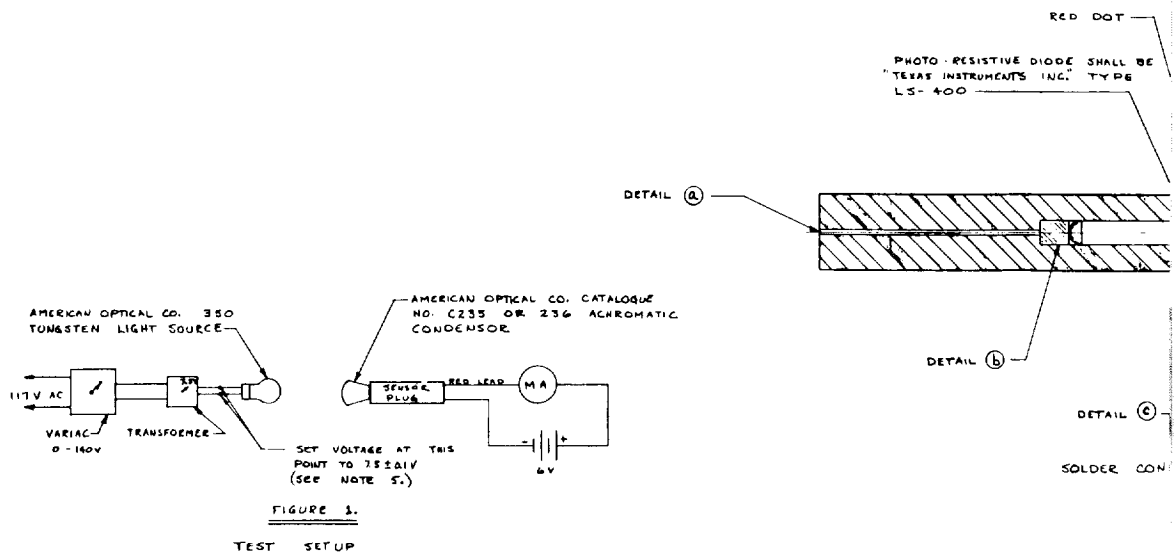
MATERIAL: FLAME POLISHED WHITE SAPPHIRE



DETAIL (b)

INFRA-RED FILTER

MATERIAL: CORNING GLASS COLOR STANDARD 1-69  
OR CORNING GLASS # 4600











## THERMOCOUPLE SENSOR

### PROCEDURE 103

#### Thermocouple Sensor Assembly

The procedural steps to fabricate thermocouple sensors are given below.

#### 1. Reference Drawings:

- (a) Thermocouple assembly (dwg No. LD-410117) figure 23.
- (b) Washer, thermocouple mounting (dwg No. LB-410124) figure 22.

#### 2. Material Required:

- (a) Ablator material, LRC control No.
- (b) Quartz tubing, 0.010-in. I.D., 0.020-in. O.D.
- (c) Shell Epon 931
- (d) Saueresein No. 1
- (e) Chromel-alumel, B and S 36 gage wire, Thermo Electric Co., Type GC-36-CCT
- (f) Chromel-alumel, B and S 30 gage wire, Thermo Electric Co., Type GC-30-CCT
- (g) Washer, mounting
- (h) Heat shrink tubing, 1/16 inch
- (i) Heat shrink tubing, 1/8 inch
- (j) 1/16-in.-diameter copper braided shield
- (k) Silicone rubber fiberglass sleeving

#### 3. Fabrication and Test Equipment Required:

- (a) VTVM, Hewlett-Packard 412 AR
- (b) Rubicon resistance bridge
- (c) Binocular microscope
- (d) Resistance welder, with weld schedules (figures 19, 20, and 21)
- (e) Heat gun
- (f) Wire spacer
- (g) Wire holding jig

#### Fabrication and Test Procedures

- 1. Machine ablator material in accordance with the detail as shown on dwg No. LD-410117. Record the LRC control number for the ablator material on the fabrication log, form RE11, figure 16.
- 2. Visually inspect the machined plug and make the following observations:

- (a) The plug shall be free of chips, cracks, and dust.
  - (b) The outer surface of the plug shall be free of excessive porosity.
3. Cut and insert quartz tubing, in accordance with dwg No. LD-410117, into slots at face end of plug and secure with Epon 931. Put in oven to cure.

NOTE

Each time Epon 931 is used, cure at 150° F for 1.5 hours.

4. Cut and strip 3-in. length of 36-gage wire, being careful to leave some of the yellow and red insulation for identification.
5. Cut 4-foot length of 30-gage wire. Strip 1/4 in. to 3/4 in. on one end according to plug length. Install and shrink a 1-inch piece of small shrink tubing on wire even with point to which wire is stripped. Install 3.75-foot braided shield 1/4 in. from strip point and secure with large shrink tubing. Slide fiberglass sleeving over cable and even with strip point.
6. Weld 3-inch length of 36-gage wire to prepared end of 30-gage wire, observing color of insulation to ensure that like wires are welded together.
7. Remove remainder of insulation from 36-gage wire and slide into rear of quartz on plug. Pull wires through quartz. Make sure that cable is tight against rear of plug, and secure wire in this position with clip.
8. Dress wires into slots on plug and fill to surface of plug with Epon 931. Put in oven and cure.
9. Remove thermocouple assembly from oven, and remove clip. Fill any voids and bond cap on plug with Epon 931. Make certain that cap is square with plug and cure in oven.
10. Prepare and make thermocouple weld at front end of plug. Dress thermocouple to proper "S" formation. Insert Saueresein No. 1 into face end of quartz about 1/8 in. Cure in oven for 15 minutes at 150° F.
11. Using the Rubicon resistance bridge, measure and record on form RE11, figure 16, forward and reverse resistances of thermocouple.
12. Using VTVM, check thermocouple weld for proper wiring by heating with soldering iron, and record results on form RE11.

NOTE

Use low temperature and extreme care to avoid damage to ablation material.

13. Measure and record physical dimensions of plug on form RE11. Measure at several points to ensure that measurements are constant.
14. Attach protective cap and washer shim to cable, and store assembly in a clean envelope with copy of form RE11.
15. The appropriate data must be recorded on form RE12, figure 17, and after installation in the nosecap the thermocouple data should be entered on the location log, form RE1, figure 18.

THERMOCOUPLE FABRICATION LOG			
Serial No.	Drawing No. 410117-	Date	
<u>DIMENSIONS</u> Length - P Diameter - Initial _____ Length - L _____ Length - M _____ Diameter - Final _____ Washer shim thickness _____		<u>CONTROL NUMBERS</u> Require Measured Checked LRC ablator batch control number T/C wire control number 30 gage T/C wire control number 36 gage	
<u>POLARITY</u> Chromel (yellow) + Alumel (red) -		<u>LOCATION</u> Install in Hole number	
<u>RESISTANCE</u>			
Forward Reverse Chromel leakage Alumel leakage	Initial		Final

Form RE11

Figure 16. Thermocouple Fabrication Log

THERMOCOUPLE PLUG AND CAP			
Ablator Material No.			
Work Order No.			
	No. mach.	Check quantity	Remarks
Drawing LD-410117 - 1			
- 2			
- 3			
- 4			
- 5			
- 6			
- 7			
- 8			
- 9			
- 10			
- 11			
- 12			
- 13			
- 14			
- 15			
- 16			
- 17			
		Total No. Plugs	
		Total No. Caps	

Form RE12

Figure 17. Thermocouple Log

THERMOCOUPLE LOCATION LOG										Date		
ASSEMBLY NO.												
Thermocouple (Mat'l No. )				Assembly (Mat'l No. )			Washer	Final electrical resistance				
Serial number	L length measured	M length measured	Diam. meas.	Hole No.	Diam. meas.	Depth meas.	"X"	Shim thickness	Pre	Post	Chromel leakage	Alumel leakage

Form RE1

Figure 18. Thermocouple Location Log



ELECTRODE PRESSURE  
(IN TERMS OF HALF-TURN DIVISIONS OF CALIBRATED  
PRESSURE CONTROL FOR THIS TYPE WELDER ONLY)

(500 SPECIMENS USED)										WELD SCHEDULE - DATE 4/23/65										EQUIPMENT USED																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
x = No Weld * = Weld Broke G = Good Weld										FOR 36 CHROMEL TO 30 CHROMEL (LAP WELD)										WELDMATIC---MODEL 1026C NASA 96573 WELDING HEAD---MODEL 1032																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
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ENERGY (WATT/SEC) (1/15 DIVISIONS)

Figure 19. Isostrength Chart, Chromel to Chromel

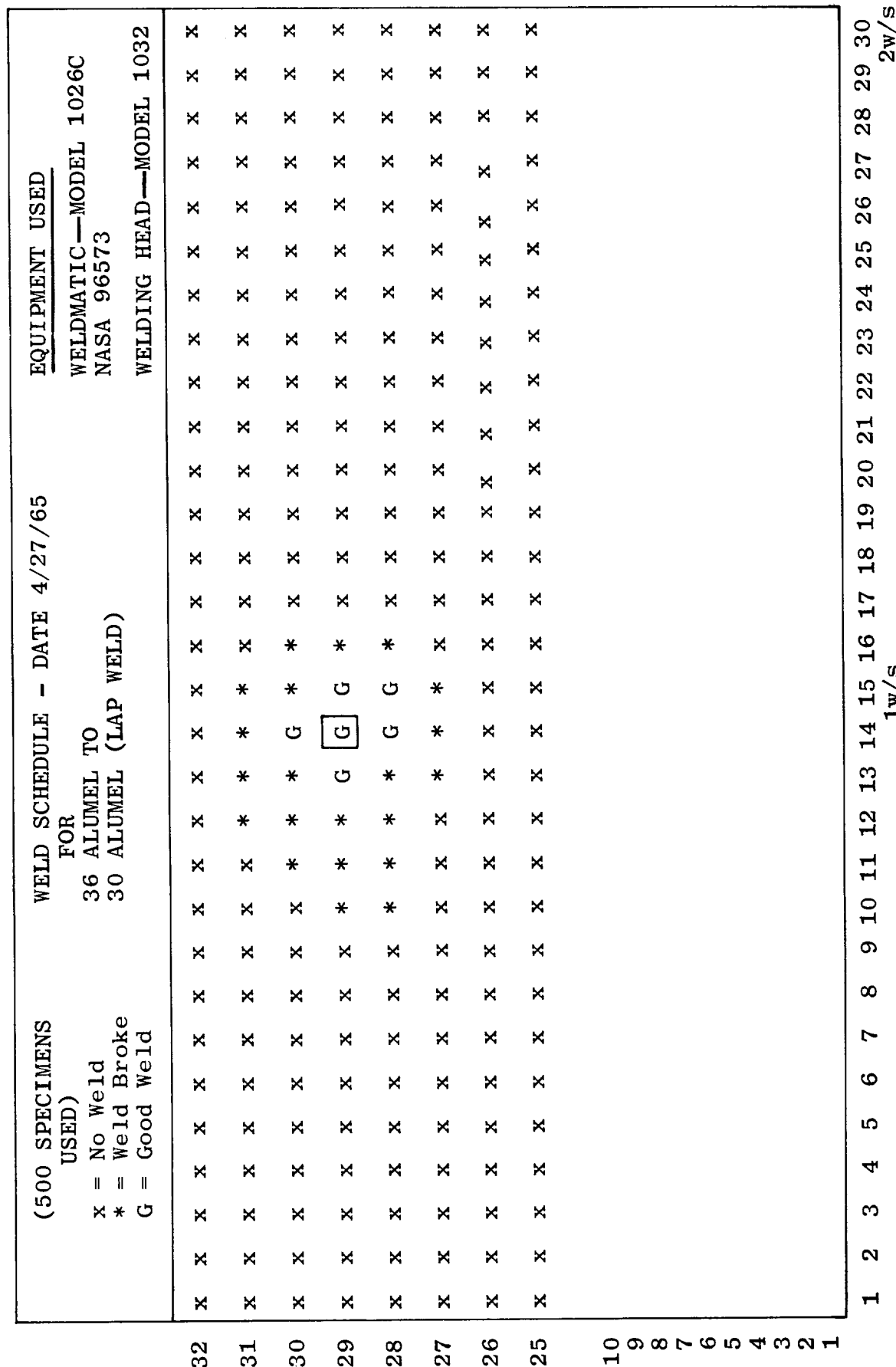


Figure 20. Isostrength Chart, Alumel to Alumel

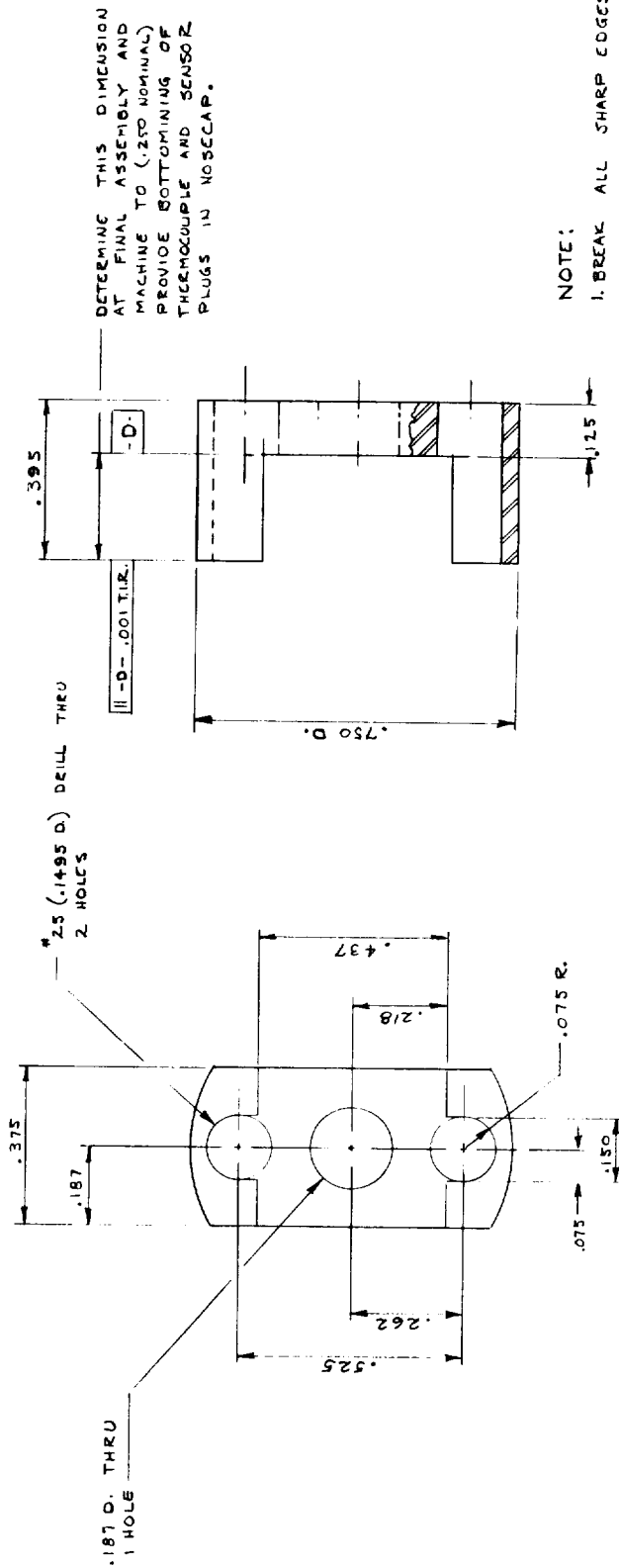
(IN TERMS OF HALF-TURN DIVISIONS OF  
ELECTRODE PRESSURE  
CALIBRATED PRESSURE CONTROL FOR THIS  
TYPE WELDER ONLY)

(500 SPECIMENS USED)			WELD SCHEDULE - DATE 4/21/65 FOR 36 CHROMEL TO 36 ALUMEL (LAP WELD)													EQUIPMENT USED WELDMATIC---MODEL 1026C NASA 96573 WELDING HEAD---MODEL 1032																
x = No Weld * = Weld Broke G = Good Weld			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
32	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
31	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
30	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
29	x	x	x	x	x	x	x	x	x	x	*	*	*	*	G	G	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
28	x	x	x	x	x	x	x	x	x	x	*	*	*	*	G	G	G	G	G	*	*	*	*	*	*	*	*	*	*	*	*	*
27	x	x	x	x	x	x	x	x	x	x	*	*	*	G	G	G	G	G	G	*	*	*	*	*	*	*	*	*	*	*	*	*
26	x	x	x	x	x	x	x	x	x	x	*	*	*	G	G	G	G	G	G	*	*	*	*	*	*	*	*	*	*	*	*	*
25	x	x	x	x	x	x	x	x	x	x	*	*	*	*	G	G	G	G	G	*	*	*	*	*	*	*	*	*	*	*	*	*
24	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	*	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
23	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
22	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
10																																
9																																
8																																
7																																
6																																
5																																
4																																
3																																
2																																
1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	2w/s	

ENERGY (WATT/SEC) (1/15 DIVISIONS)  
Figure 21. Isostrength Chart, Chromel to Alumel

2w/s

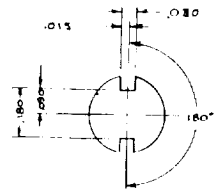
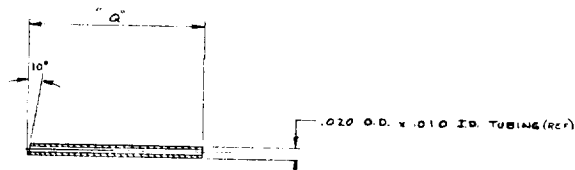
1w/s



DATE	LET.	REVISION	BY	UNIT OR PROJECT	SCALE	MATERIAL	HEAT TREAT	REVIEWED BY	UNIT
				SCOUT REENTRY	4/	TYPE 416 STAINLESS STEEL		DR. D. J. H. 4 - 63	
				NEXT ASSEMBLY		NATIONAL AERONAUTICS AND SPACE ADMINISTRATION		CHK. 5/5/63	
				TOLERANCE ON DIMENSIONS UNLESS SHOWN OTHERWISE	XX (1 DECIMAL PLACE) ± .1 XXX (3 DECIMAL PLACES) ± .01 XXXX (3 DECIMAL PLACES) ± .005	LANGLEY RESEARCH CENTER LANGLEY STATION		Q.L.	
				ANGULAR ±		WASHER RETAINING		AP.	
				SURFACE FINISH IN MICROINCHES RMS UNLESS SHOWN OTHERWISE	63	PHENOLIC NYLON NOSECAP (R-E)		SHEET SIZE	410124
								LB	

TOTAL REQD.

Figure 22. Phenolic Nylon Nosecap Retaining Washer



DETAIL (A)

QUARTZ TUBING  
MATERIAL: .020 O.D. x .010 I.D. QUARTZ  
TUBING.

BOND QUARTZ TUBING IN PLACE AND  
FILL SLOT, AFTER T.C. WIRE HAS BEEN  
INSTALLED, WITH SHELL EPON #931

APPLY SAUCEISEN #20 CEMENT  
INSIDE QUARTZ TUBING APPROX  
1/8" DEEP FROM HOT END

.248 D. (REF) TO PROVIDE LIGHT PUSH  
FIT WITH LX-410115

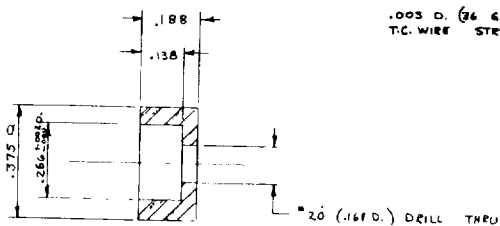
1-C. .001 T.I.E

HOT JUNCTION  
RESISTANCE LAP WELD

DETAIL (A)  
2 REQD.

.003 D. (36 GAGE) CHROMEL - ALUMEL  
T.C. WIRE STRIPPED OF ALL INSULATION

JOIN .005 D. (36 GAGE) T.C. WIRE  
TO .010 D. (30 GAGE) WITH RESISTANCE  
LAP WELD (CHROMEL TO CHROMEL  
AND ALUMEL TO ALUMEL)

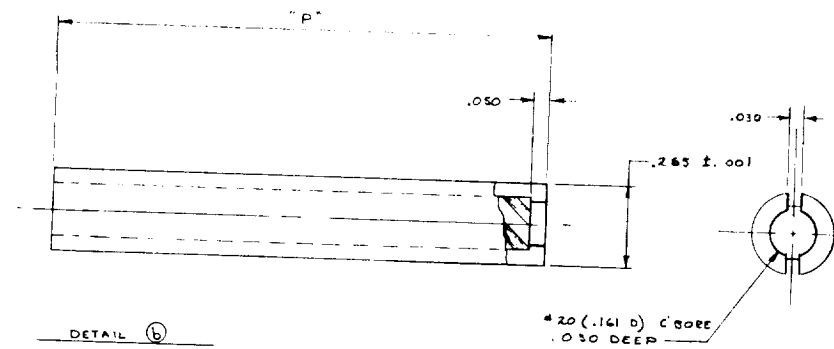


DETAIL (C)

CAP

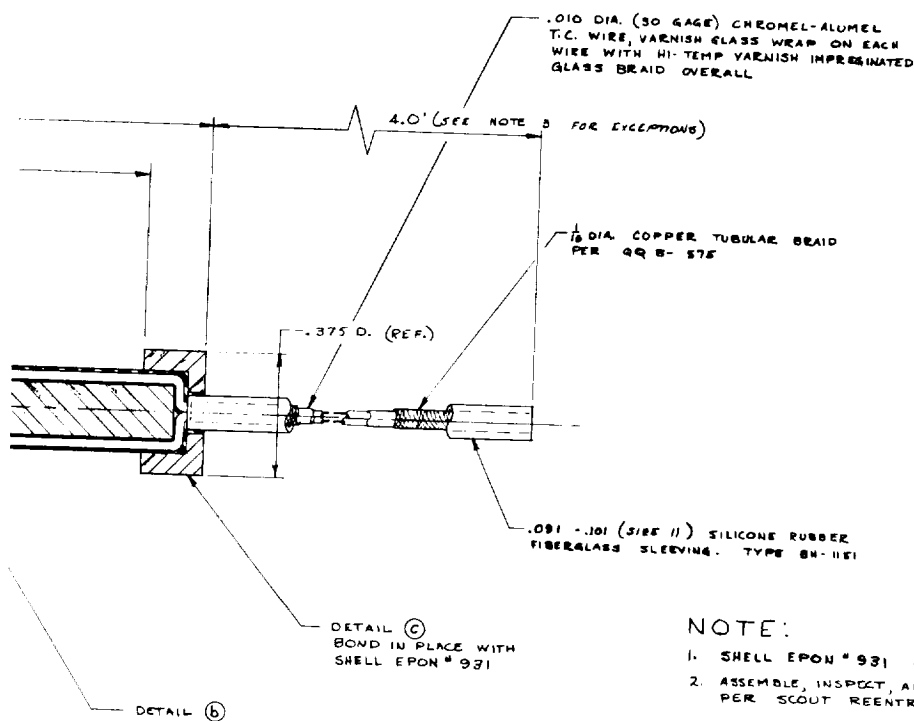
MATERIAL: PHENOLIC NYLON AS PER SCOUT  
REENTRY HEATING PROJECT PROCEDURE 104





DETAIL (b)  
PLUG  
MATERIAL: PHENOLIC NYLON AS PER SCOUT  
REENTRY HEATING PROTECT PROCEDURE 104

DRAWING NO.	'P'	'Q'	'L'	TOTAL ACQD.
LD-410117 - 1	2.180	1.00	2.200	
- 2	2.100		2.150	
- 3	2.050		2.100	
- 4	2.000		2.050	
- 5	1.900		1.950	
- 6	1.800		1.850	
- 7	1.750		1.800	
- 8	1.700		1.750	
- 9	1.650		1.700	
- 10	1.600		1.650	
- 11	1.500	1.00	1.550	
- 12	1.400	.50	1.450	
- 13	1.300		1.350	
- 14	1.200		1.250	
- 15	1.100		1.150	
- 16	.950	.50	1.000	
- 17	1.950	1.00	2.000	



#### NOTE:

1. SHELL EPON # 931 SHALL BE CURED AT 150°F FOR 3 HRS.
2. ASSEMBLE, INSPECT, AND TEST TEMPERATURE SENSORS AS PER SCOUT REENTRY HEATING PROTECT PROCEDURE 103
3. THIS LENGTH SHALL BE 15.0" FOR ALL THERMOCOUPLE ASSY'S USED FOR ARC JET SPECIMENS.
4. MEASURE AND RECORD "M" DIMENSION ON LOG SHEET PROVIDED IN SCOUT REENTRY HEATING PROTECT PROCEDURE 106 AFTER ASSEMBLED PLUG HAS BEEN MACHINED TO 248 REF. DIA.

DATE	LET.	REVISION	BY	LD-410117	UNIT OR PROJECT	SCALE	MATERIAL	HEAT TREAT	REVIEWED BY	UNIT
				NEXT ASSEMBLY	SCOUT REENTRY HEATING	4/1	NOTED		T.P.E. [Signature]	4/1
				TOLERANCE ON DIMENSIONS			NATIONAL AERONAUTICS AND SPACE ADMINISTRATION		DR. [Signature]	
				UNLESS SHOWN OTHERWISE			LANGLEY RESEARCH CENTER		CHK.	
				ANGULAR			LANGLEY STATION		GL	
				SURFACE FINISH IN			DETAIL ASSEMBLY, THERMOCOUPLE		AP	
				MICROINCHES RMS			PHENOLIC NYLON NOSECAP (R-E)		SHEET	
				UNLESS SHOWN OTHERWISE					SIZE	
									LD	410117

Figure 23. Thermocouple Detail Assembly.





## MOLDING ABLATOR

### PROCEDURE 104

#### Ablator, Phenolic Nylon Nosecap

Molding of the ablator material was accomplished using the following steps.

##### 1. Reference Drawings and Sketches:

- (a) Ablator contour - (LRC Dwg No. LC-410120) figure 28
- (b) Nose cap mold - LRC Dwg No. LX-409155
- (c) Thermocouple sensing probe - LRC Dwg No. LB-410318
- (d) Sketch No. 1, figure 27, mold thermocouple and pressure transducer locations

##### 2. Materials Required:

- (a) Powdered 66 Nylon Dupont Zytel 103, MP and DS Control No. L64-6D.615.L261968/C
- (b) Powdered phenolic resin, Union Carbide Corporation's BRP-5549, MP and DS Control No. U2-19D.576.L60248/C
- (c) Phenolic microballoons, Union Carbide Corporation's BJO-0930, MP and DS Control No. U2-19D.620.L1986/C.
- (d) Vinyl tape, Federal Stock No. 8135-634-3330
- (e) TF freon precision cleaning agent, E. I. Dupont
- (f) Methyl ethyl ketone solvent, Federal Stock No. 6810-281-2762
- (g) Miller-Stephenson MS-122 parting agent
- (h) Iron-constantan thermocouple wire, certified calibration
- (i) Chromel-alumel thermocouple wire, certified calibration
- (j) Liquid argon gas
- (k) Ram Chemical Company's Plastilease 344
- (l) Copies of purchase specifications and manufacturer's certifications of materials attached

##### 3. Equipment Required:

- (a) Processor, Patterson-Kelly, 5 cu ft capacity
- (b) Processor, Patterson-Kelly, 1 cu ft capacity
- (c) Blackstone ultrasonic degreaser, Model VR-20-3
- (d) Shadowgraph scale, Model 4112-HB
- (e) Barber-Coleman pressure transducer system, composed of pressure recorder console and 6 calibrated transducers, 0 - 10,000 psi, pressure calibration chart attached
- (f) Press, Oliver, 500-ton capacity
- (g) Nosecap mold
- (h) Thermocouple sensing probe
- (i) Millimeter vacuum gage

- (j) 200 C.F.M. vacuum pump
- (k) Honeywell-Brown recorder, 0 - 600°F, iron-constantan. Certified calibration No. 30 and 36 gage I.C. thermocouple wire.
- (l) Honeywell-Brown recorder, 0 - 10000 F, chromel-alumel. Certified calibration No. 30 gage C.A. thermocouple wire.
- (m) Inch-pound torque wrench
- (n) Oven, air circulating, 0 - 600° F, program-controlled
- (o) Oven retort, stainless steel
- (p) Argon flow meter
- (q) Grain sampler, Dean Gamet Mfg. Co.

### Raw Materials Sampling Procedure

1. Presampling of each raw ingredient container for particle size distribution study is performed in the following manner:
  - (a) Identify each raw material container of nylon, microballoons, and phenolic resin with a letter designation in the order listed below.
    1. Three nylon containers - containers A, B, and C.
    2. Four microballoon containers - containers D, E, F, and G.
    3. One phenolic resin container - container H.
  - (b) Insert a probe grain sampler vertically in the storage drum center while sampler is in a closed position.
  - (c) Tilt the storage drum as far as possible without disturbing the material, having the sampler openings facing upward.
  - (d) Open the sampler to permit the material to fill the six sampler cavities. Close the sampler, right the drum, and remove the sampler from the drum.
  - (e) Open the sampler and remove the material samples. Package the material in a polyethylene bag, and identify with a sampler zone number and drum letter designation. Identify each bag as to material that has not been processed.
  - (f) Empty the contents of the storage drum into the 5-cu ft blender and mix for 15 ±2 minutes.
  - (g) Empty mixed material from blender back into original storage container, and sample as directed in steps 1(a) through 1(d). Identify the samples as having been mixed as directed in step 1(f) above.
2. The following procedure is used to sample the individual raw materials, nylon, phenolic resin, and phenolic microballoons, for evaluation by Hughes Aircraft Co. on Contract No. NAS2-2739. Samples are taken of each ingredient prior to processing each individual raw material for molding. Determine the level to

which the material storage drum is filled, as received from the manufacturer. Mark a pencil line on the outside of the drum at this level. Divide and number the drum into eight equal zones from top to bottom, starting with zone No. 1 at the top. For example, container A, B, C, etc., and individual container zone A1, A2, A3, etc.

3. Weigh out the proper amount of raw material, in accordance with 1(a), 2(a), and 3(a) on the shadowgraph scale, into a clean polyethylene container.
4. Vacuum out the P-K blender mix hopper and clean with a clean cloth moistened with TF freon.
5. Load the blender with the individual raw material being sampled and mix for  $10 \pm 2$  minutes at  $8 \pm 1$  rpm hopper speed.
6. Weigh out one-half pound of mixed material on shadowgraph scale into a polyethylene bag. Heat-seal bag opening. Repackage unused raw material in polyethylene container, for further processing. Seal lid of container with vinyl tape, Federal Stock No. 8135-634-3330.
7. Assign a number to the sample, using the numbering sequence given in figure 26, and identify the bag with this number. Record this number on, and complete three copies of, the sampling log sheet, form RE7, figure 25. Affix one copy of sampling log sheet to bagged sample with masking tape, attach second copy to this procedure, and retain third copy for MP and DS Files.
8. Package sample in a one gallon, wide-mouth metal container for shipment. Where volume of one-half pound sample is too large to fit in a gallon container, divide the sample into a suitable number of smaller bags. Identify each bag with sample number.
9. Initiate LRC Shipping Order, Form P.C. 36F099. Ship to:

Mr. L. B. Keller  
Hughes Aircraft Company  
Bldg. 32, Mail Station H-164  
Culver City, California

#### Material Formulation and Compounding

The material formulation is composed of the following percentages by weight of nylon, phenolic resin, and phenolic micro-balloons:

40-percent powdered nylon, Zytel 103  
25-percent phenolic resin, BRP-5549  
35-percent phenolic microballoons, BJO-0930

# 1. Preprocessing of Nylon

- (a) Degrease polyethylene material container in freon. Refer to paragraph 2 under Raw Materials Sampling Procedure for zone identification of raw material storage drum. Weigh out 2,650 grams of nylon in the container on Shadowgraph scales.
- (b) Take from this weighing a sample of approximately 60 grams. Package the sample in a heat-sealed polyethylene bag. Assign a number to the sample. Identify it and ship to chemical laboratory for moisture content analysis. Record the following data:

Record sample No.: \_\_\_\_\_

Record moisture content: \_\_\_\_\_ percent.

Record information on form RE6, figure 24

- (c) Sample weighing as directed in paragraphs 4 through 9 under Raw Materials Sampling Procedure.
- (d) Secure hopper lids and dry as follows:

180  $\pm$ 5 minutes at 200  $\pm$ 5 F

29  $\pm$ 1 inches of mercury

5  $\pm$ 1 rpm hopper speed

Record mix time: \_\_\_\_\_ minutes.

Record hopper temp: \_\_\_\_\_ F.

Record hopper rpm setting: \_\_\_\_\_ rpm.

Record vacuum: \_\_\_\_\_ in. mercury.

- (e) Remove dried material from blender and place in polyethylene container. Take a sample as directed in step 1(b). Use same sample number with a letter suffix to show that sample has been dried.

Record sample No.: \_\_\_\_\_

Record moisture content: \_\_\_\_\_ percent.

Record information on form RE6.

- (f) Reweigh nylon on shadowgraph scale and adjust weight to  $2,060 \pm 5$  grams for correct percentage of total formulation weight.

Record weight: \_\_\_\_\_ grams.

Seal lid of polyethylene container with vinyl tape, Federal Stock No. 8135-634-3330.

- (g) Mark on the container with a brush pen the total material weight, the time of day, and the date. Predried material shall be compounded into a batch formulation within 48 hours.
- (h) Record weight of nylon, reference step 1(b), on fabrication log sheet, form RE6.

## 2. Preprocessing of Phenolic Resin

- (a) Degrease polyethylene material container in Blackstone degreaser with freon. Refer to paragraph 2 under Raw Materials Sampling Procedure for zone identification of raw material storage drum. Weigh out 1,830 grams of phenolic resin in the container on the shadowgraph scales.
- (b) Take from the weighing a sample of approximately 60 grams. Package the sample in a heat-sealed polyethylene bag. Assign a number to the sample. Identify it and ship to chemical laboratory for moisture content analysis.

Record No.: \_\_\_\_\_

Record moisture content: \_\_\_\_\_ percent.

Record information on form RE6.

- (c) Sample weighing as directed in paragraphs 4 through 9 under Raw Materials Sampling Procedure.
- (d) Remove material from blender and reweigh on shadowgraph scales. Adjust weight to  $1,287 \pm 5$  grams for correct percentage of total formulation weight.

Record weight: \_\_\_\_\_ grams

Seal lid of polyethylene container with vinyl tape, Federal Stock No. 8135-634-3330.

- (e) Record weight of phenolic resin on fabrication log sheet, form RE6.

## 3. Preprocessing of Microballoons

- (a) Degrease polyethylene material container in Blackstone degreaser with freon. Refer to paragraph 2 under Raw Materials Sampling Procedure for zone identification of raw material storage drum. Weigh out 2,400 grams of microballoons in the container on shadowgraph scales.

- (b) Take from this weighing a sample of approximately 60 grams. Package the sample in a heat-sealed polyethylene bag. Assign a number of the sample. Identify it and ship to chemical laboratory for moisture content.

Record Sample No.: \_\_\_\_\_

Record moisture content: \_\_\_\_\_ percent.

Record information on Form RE6.

- (c) Sample weighing as directed in paragraphs 4 through 9 under Raw Materials Sampling Procedure.
- (d) Secure hopper lids and dry as follows:

180  $\pm$ 5 minutes at 200  $\pm$ 5° F.

29  $\pm$ 1 inches of mercury.

5  $\pm$ 1 rpm hopper speed.

Record mix time: \_\_\_\_\_ minutes.

Record hopper temp: \_\_\_\_\_ F.

Record hopper rpm setting: \_\_\_\_\_ rpm (setting No. 2).

Record vacuum: \_\_\_\_\_ in. mercury.

- (e) Remove dried material from blender and place in polyethylene container. Take a sample as directed in step 3(b). Use same sample number as assigned in step 3(b) and assign a letter suffix to indicate that sample has been dried.

Record sample No.: \_\_\_\_\_

Record moisture content: \_\_\_\_\_ percent.

Record information on form RE6.

- (f) Reweigh microballoons on shadowgraph scales, and adjust weight to 1,803  $\pm$ 5 grams for correct percentage of total formulation weight.

Record weight: \_\_\_\_\_ grams.

Seal lid of polyethylene container with vinyl tape, Federal Stock No. 8135-634-3330.

- (g) Mark on the container with a brush pen the total material weight, the time of day, and the date. Predried material shall be compounded into a batch formulation within 48 hours.

- (h) Record weight of microballoons, reference step 3(b), on fabrication log sheet, form RE6.

#### 4. Composition Batch Formulation

- (a) Record the formulation weights of each raw material, and assign a batch control number to the formulation

25 percent phenolic resin: \_\_\_\_\_ grams

40 percent nylon: \_\_\_\_\_ grams

35 Percent microballoons: \_\_\_\_\_ grams

Batch number: \_\_\_\_\_

Record information on form RE6.

- (b) Load the hopper with predried microballoons by sifting them through a No. 20, U.S. standard mesh screen. Degrease screen in Blackstone degreaser with freon before using.
- (c) Mix for  $5 \pm 1$  minutes at room temperature using  $14 \pm 1$  rpm hopper speed, without vacuum.

Record mix time: \_\_\_\_\_ minutes.

Record hopper rpm setting: \_\_\_\_\_ rpm.

- (d) Load hopper with predried nylon by sifting through No. 20, U.S. standard mesh screen. Mix for 2 minutes with intensity bar after addition of all nylon.
- (e) Mix nylon and microballoons together for  $10 \pm 2$  minutes at room temperature and  $14 \pm 1$  rpm hopper speed, without vacuum.

Record mix time: \_\_\_\_\_ minutes.

Record hopper rpm setting: \_\_\_\_\_ rpm

- (f) Visually inspect mix for improper mixing or lumping.
- (g) Load the hopper with phenolic resin by sifting through a No. 20, U.S. standard mesh screen. Mix for 2 minutes with intensity bar after addition of all phenolic resin.
- (h) Mix nylon, microballoons, and phenolic resin together for  $10 \pm 2$  minutes at room temperature and  $14 \pm 1$  rpm hopper speed, without vacuum. Visually inspect for proper mixing.

Record mix time: \_\_\_\_\_ minutes.

Record hopper rpm setting: \_\_\_\_\_ rpm.

- (i) Remove a one-half pound sample of material and heat-seal in a polyethylene bag. Identify bag with batch number.
- (j) Package and ship in accordance with paragraphs 8 and 9 under Raw Materials Sampling Procedure.

- (k) Empty formulated batch from blender into a suitable size preweighed polyethylene bag. Reweigh batch on shadowgraph scales, and adjust weight to  $4,805 \pm 100$  grams for correct mold charge weight.

Record weight: \_\_\_\_\_ grams

- (l) Seal neck of polyethylene bag by twisting several times and folding it back on itself. Secure with masking tape and place bag in polyethylene container. Seal lid of polyethylene container with vinyl tape, Federal Stock No. 8135-634-3330. Mark with a brush pen on the side of the container the time of day, the date, and the molding composition weight and batch number. Store at room temperature.
- (m) Formulated batch must not be stored for more than 72 hours prior to molding.

#### Mold Assembly and Instrumentation

1. Refer to sketch No. 1 (figure 27) of this procedure for proper location and numbering sequence of all thermocouples and pressure transducers.
2. Position two steel adapter blocks on bottom press platen. Position two silicone laminate insulating plates, one on each block, on top of steel adapter blocks. Position and align heating platen on top of insulating plates, and dog down with tie rod studs. Align mold base plate in the molding press on the lower heating platen, and secure with machine screws.
3. Using an ohmmeter, check electrical continuity of thermocouples No. 7 and 8, which are welded to the inside bottom face of mold plunger.
4. Connect water lines and fittings to two calibrated transducers, and install the transducers in the mold plunger at transducer locations No. 2 and 3. Torque each transducer to 50 in. -lb. Record the transducer number and serial number relative to its location. Reference should be made to the transducer calibration chart.

Location No. 2 - Transducer No.\_\_\_\_, Serial No.\_\_\_\_

Location No. 3 - Transducer No.\_\_\_\_, Serial No.\_\_\_\_

5. Position the 3.4-in. thick silicone laminate insulation plate and the 2-in. thick steel adapter plate on top of mold plunger. Secure to plunger with Allen head machine screws.
6. Center the mold plunger in the molding press on top of the mold base, using the base plate "O" ring groove as a reference.
7. Thread the transducer leads, the water lines, and the thermocouple leads through the opening in the top press platen.



8. Raise the mold plunger into place by slowly closing the molding press. Fasten it to the top platen with machine screws.
9. Lower the press and remove the mold base plate from the molding press.
10. Install the thermocouple temperature probe in the mold base plate. Check the electrical continuity of thermocouples No. 4, 5, and 6 with an ohmmeter.
11. Align the mold base plate in the molding press on the lower heating platen. Fasten to heating platen with Allen head machine screws. Install a calibrated pressure transducer in the mold base plate at transducer location No. 1. Torque to 50 in.-lb. Connect the water lines and fittings to the transducer. Record the transducer number and serial number.

Location No. 1 - Transducer No. \_\_, Serial No. \_\_\_\_

12. Using a clean cloth moistened with methyl ethyl ketone, solvent-clean the mold base plate, male plunger, and female cavity in all areas that will come in contact with the molding compound. Repeat cleaning operation using TF freon solvent.
13. Apply Ram Chemical Company's Plastilease 334 wax and rub out. Spray two thin, uniform coatings of Miller-Stephenson MS-122 parting agent on cleaned mold areas, wiping off excess between first and second coat.
14. Install silicone "O" ring in mold base plate "O" ring groove. Install silicone "O" ring on outside diameter of mold plunger. Push "O" ring to top of plunger.
15. Position and align mold female cavity on mold base plate in base plate index flange. Check alignment of female cavity with mold plunger by closing press and shifting female cavity as needed. Fasten female mold cavity to press platen with two sets of studs and dogs.
16. Connect thermocouple leads No. 1 through 12 to the correspondingly numbered channels of the Honeywell-Brown temperature recording instrument. As a check for correct operation, turn the instrument on and record the ambient temperature of each thermocouple.

#### NOTE

The Honeywell-Brown temperature recording instrument is automatically controlled so that it will make a temperature record at 11.5-minute intervals. The time required to make a single plot is 30 seconds. It

can also be manually controlled to print 100 percent of time by turning off clock control switch and turning on chart drive switch.

17. Connect the inlet water lines of all pressure transducers to the water source valve. Place the outlet water lines in the end of the main water line drain hose. Turn on the water and check each transducer outlet hose for the proper amount of water flow.
18. Fasten the electrical pressure leads coming from the pressure transducers at locations No. 1, 2, and 3 to the correspondingly numbered channels of the Barber-Coleman pressure recording instrument. Turn the instrument on and run through a trace of each transducer. The trace of each should indicate 0 pressure. Turn the instrument off.
19. Make up all steam line connections to the mold bottom heating platen, male plunger, and mold female cavity.

#### Molding Procedure

1. Cut out one 12-inch diameter disc of 1/8-inch thick fiberfrax (aluminum-silicate) felt. Cut out three 12-inch diameter discs of 15-mil square weave fiberglass cloth. Cut out a suitable size hole in the correct location so that the thermocouple probe can protrude through.
2. Position the four layers of the above material on the mold base plates so that the fiberglass cloth is on the bottom. These layers constitute the bottom volatile sink.
3. Remove the formulated molding compound from the storage room. Unseal the polyethylene container and remove bag from the container. Assign an ablator molding number to the composition, and record.

Ablator Molding No. \_\_\_\_

4. Remove the tape from the neck of the polyethylene bag. Holding the neck closed (folded on itself) with one hand and the weight of the bag with the other hand, insert the bag, neck end down, in the mold cavity until the bag rests on the mold base plate.
5. Release the neck of the bag and gently withdraw it from the mold cavity by grasping it at the bottom with both hands. Gently shake the bag during the withdrawing operation to ensure complete emptying.

6. Record the shop work area temperature and relative humidity during the loading operation.

Temperature: \_\_\_\_\_ F. \_\_\_\_\_

Relative humidity: \_\_\_\_\_ percent.

7. Using a small straightedge 4 to 6 inches long, grade the top of the molding composition level.
8. Cut the volatile sink material as directed in step 1 above, omitting hole in approximate center, and position the material on top of the leveled composition so that the fiberfrax felt is in contact with the molding composition.
9. The following steps 10 through 18 are a specialized technique developed for, and adapted to, the existing LRC molding equipment. To meet the acceptance criteria as to bulk and unit density variation of ablator moldings, it is necessary to control the unit density at the top and bottom. This is accomplished by compressing the molding composition 7/8 inch beyond its normal thickness of 4-1/2 inches at room temperature. The composition is allowed to recover under the dead weight of the top press platen and male plunger (2,011 lb) to 4-1/2 inches.
10. Measure to the nearest 1/4 inch the distance from the top of the volatile sink to the top of the female mold cavity, using a 24-inch scale and square head. Add 1-1/2 inches to this measurement, and measure up from the bottom of the mold plunger using this dimension. Using a crayon pencil, mark a line on the male plunger (reference line "A") to represent this dimension.
11. Energize the molding press hydraulic pump motor. Set the control index on the press control on COMPRESSION. Lift the arm on the limit switch marked LS-4 SLOW APPROACH with left hand.
12. With the right hand push in the CYCLE START button. As press starts closing on slow approach, release the limit switch arm and place right hand on CONTROL INDEX switch. When the top surface of the female cavity reaches reference mark "A" on the mold plunger, turn the CONTROL INDEX switch to the MANUAL position. Press travel will cease and hold at this reference mark. Turn the press pump motor off.
13. Connect one vacuum line from vacuum pump to top of mold female cavity and one vacuum line to mold base plate. Refer to figure 16. Slide the "O" ring around the mold plunger down into the "O" ring groove at top of mold female cavity. Close both vacuum valves on vacuum manifold.
14. Turn on the vacuum pump. Open the vacuum valve which controls the vacuum line to the mold base plate. Evacuate the mold

cavity through this line at a rate of  $38 \pm 5$  millimeters mercury per minute. Evacuate cavity to  $5 \pm \frac{0}{5}$  millimeters mercury. Open vacuum line to top of female cavity. Evacuate cavity through both lines for  $40 \pm 5$  minutes. Record maximum vacuum pressure and total time evacuated.

Maximum vacuum pressure: \_\_\_\_\_ mm.

Total time: \_\_\_\_\_ minutes.

15. Position two steel stop shims,  $1 \times 6\text{-}1/8 \times 8$  inches, on top surface of female mold cavity, one on each side,  $180^\circ$  apart. Use the  $6\text{-}1/8$  inch dimension as the shim height. The shims should be placed in such a manner that when the press closes they will land on the mold plunger adapter plate.
16. Turn on the Barber-Coleman recording instrument to record pressure. Record on the recording chart the start of stress relief cycle, ablator molding number, date, and time of day. To conform to the processing criteria of this procedure, one of the three pressure transducers must be recording properly the pressure on the material composition during molding cycle only. Energize the press hydraulic pump motor. Position the CONTROL INDEX switch on the press control panel to COMPRESSION. With left hand, lift arm of limit switch marked LS-4 SLOW APPROACH. Depress CYCLE START button with right hand. As press closes on slow approach, maintain a uniform closing speed by increasing the clamp pressure.
17. Immediately after shim stops land on plunger adapter plate, back off the clamp pressure to the minimum available pressure, which is approximately 100 tons. Turn CONTROL INDEX switch to MANUAL. Start opening the press with the CLAMP INCH-DOWN BUTTON. Stop when daylight appears between the top molding press bolsters and the insulation plate. Turn off the hydraulic pump motor. Hold this position with no more than  $3/8$ -inch maximum daylight showing while the molding compound recovers  $7/8$  inch. Record the length of time required for molding compound to recover, using a stop watch.

Time to recover: \_\_\_\_\_ min \_\_\_\_\_ sec

18. Position two steel shims  $7/8$ -inch thick, one each on the  $6\text{-}1/8$ -inch shim stops. Energize hydraulic pump motor and reclose press on shim stops as in step 16 using 90- to 100-ton clamp pressure.

## Cure Cycle

1. Mark a pencil line on the Barber-Coleman pressure recording chart and the Honeywell-Brown temperature recording chart and label as START OF THE CURE CYCLE. Record on the Honeywell-Brown recording chart the ablator molding number, date, and time of day. Turn on the chart drive switch for full time recording.
2. Close the steam valve to the lower heating platen.
3. Open the steam valve to the mold male plunger and female cavity. Set the steam pressure at 40 lb, and heat-mold for  $30 \pm 5$  minutes at this pressure.
4. After 30 minutes raise the steam pressure on the mold male plunger to 60 lb and on the mold female cavity to 75 lb. Heat at this new setting for 2 hours  $\pm 5$  minutes. After 2 hours turn on the steam to the bottom heating platen. Adjust the top and bottom steam pressure regulator valves to raise the mold temperature to  $335 \pm 5^{\circ}$  F, which is controlled by thermocouples No. 2 and No. 3. In making this adjustment, set the top steam pressure regulator valve  $15 \pm 4$  lb below the setting of the bottom regulator valve. To conform to the process criteria of this procedure, only one of these thermocouples must be recording at all times during the cure cycle.
5. After balancing out the mold temperature to  $335 \pm 5^{\circ}$  F, set up timer of Honeywell-Brown recorder for 4 percent time on. Turn off manual chart drive control switch and turn on timer control switch.
6. Heat the molding composition at  $315 \pm 10^{\circ}$  F using any one of the three probe thermocouples (No. 4, 5, and 6) as the temperature control point. To conform to the process criteria of this procedure, only one of these thermocouples must be recording at all times during the cure cycle. Record the time required to reach the cure temperature based on the starting time and the temperature point at which the cure time starts.

Temperature point: \_\_\_\_\_ F. \_\_\_\_\_

Time required to reach cure temp: \_\_\_\_\_ hr \_\_\_\_\_ min.

7. Cure at  $315 \pm 10^{\circ}$  F for 3 hours  $\pm 10$  minutes. Mark on the temperature recording chart the point where the curing time starts and ends, and record here the total curing time.

Curing time: \_\_\_\_\_ hr \_\_\_\_\_ min.

8. At the end of cure time, turn off steam and vacuum to mold. Return the CONTROL INDEX SWITCH to MANUAL. Shut off the molding

press hydraulic pump motor. Turn off the Barber-Coleman pressure recording instrument. Do not turn off the Honeywell-Brown temperature recording instrument.

9. Cool the molded ablator in the mold to  $275 \pm_{10}^0$  ° F, as indicated by probe thermocouple control point, before removing. Turn off the Honeywell-Brown temperature recorder. Turn off water to transducers.
10. To remove the molded ablator from the mold, proceed as follows:
  - (a) Energize the hydraulic pump motor on the press. Lower the press until the mold plunger is 1 to 2 inches from becoming disengaged from the mold female cavity.
  - (b) Remove vacuum lines and vacuum port nipple from female mold.
  - (c) Disconnect copper steam lines from female mold, and remove holdown machine screws.
  - (d) Push female support carriage into place.
  - (e) Open press until female mold engages in support carriage and bottom of female mold is 2 inches above mold base plate.
  - (f) Lift ablator molding off mold base plate back into female mold cavity, and support it at this position.
  - (g) Open press to full opening and shut off hydraulic pump motor.
  - (h) Roll carriage out of molding press and remove ablator molding from mold.
11. Place ablator molding in an insulated container as soon as it is removed from the mold, and allow it to cool for  $10 \pm 2$  hours. The insulated container shall be at room temperature.
12. Remove the volatile sink material from top and bottom of ablator molding. Identify the molding as Scout RE, with formulation batch number and molding number. Affix identification tag of embossed aluminum pressure-sensitive tape to the diameter of the cake.

Example - Scout RE.FB-1.AM-1  
                    Formulation Batch - FB  
Ablator      Molding - AM

13. Remove from the Barber-Coleman and Honeywell-Brown recorders the chart paper of the cure cycle. Draw a single graphical plot of the time, temperature pressure curves. Identify the graph as form RE8 and record the date, job order, formulation batch number, and molding number. Attach to form RE8 (figure 39) of this procedure recording charts and graph.
14. Machine  $1/8$  inch from top and bottom of the molded cake, holding the faces parallel within 0.003 inch. Machine the cake dry.

### Post Mold Density Determination

1. Refer to form RE6 and record all pertinent calculations as developed. Remove the identification tag.
2. Weigh the ablator molding to the nearest 0.001 pound.
3. Divide the ablator molding on bottom face into six equal spaces, marking the division points with a soft lead pencil. Connect the diagonally opposite points with a line drawn through the center. Measure in from the diameter, 1 inch from outer edge on each line.
4. With a micrometer measure the ablator thickness at the six location points to the nearest 0.0001 inch. Calculate the thickness of the ablator molding as an average of these measurements.
5. Measure with a micrometer the diameter of the ablator molding to the nearest 0.0001 inch. Make these diameter measurements at three different points, and calculate the ablator molding diameter as an average of these measurements.
6. Calculate the bulk density of the ablator molding in pounds per cubic foot ( $\text{lb/ft}^3$ ).

### Ablator Molding Post-Cure Cycle

1. Post-curing of one to three ablator moldings can be performed simultaneously. When two or three ablator moldings are post-cured at the same time, surface thermocouple No. 3 (Program Controller), as described in paragraphs 2 and 3 below, shall be bonded to one of the ablator moldings only.
2. Instrument the ablator molding with three ball junction, No. 30 gage, chromel-alumel thermocouples, 15 feet long. Place one (1) thermocouple in the bottom of the cavity created by the thermocouple temperature probe. Pack the cavity with quartz felt. Bond the other two thermocouples side by side, approximately 1/2 inch to 3/4 inch apart 2 inches in from the outer edge. Bond thermocouples to the surface of the ablator with Saueresein No. 1. Air-dry the ceramic cement, and allow cement to cure at room temperature for 4 hours.
3. Number the thermocouple secured in probe cavity No. 1, and connect it to the Honeywell-Brown recorder. Number the two outside surface thermocouples No. 2 and No. 3. Connect No. 2 to the Honeywell-Brown recorder. Connect No. 3 to the program controller as the control thermocouple. Note that thermocouple No. 3 is required on only one ablator molding if more than one ablator is being post-cured at the same time.

4. Place the ablator molding(s) in an oven retort in an air-circulating oven. Hook up argon line from retort to argon source. Adjust the argon flow to the retort at eight retort volumes per hour, or  $25 \pm 5$  cubic feet per hour.
5. Set up the program controller, which is controlled by thermocouple No. 3, as follows:
  - (a) Raise temperature from  $100^{\circ}$  to  $300^{\circ}$  F at the rate of  $5^{\circ}$  F per hour.
  - (b) Hold at  $300^{\circ}$  F for 22 hours.
  - (c) At the end of 22 hours, turn off heating elements of oven but keep oven blower on. Allow oven to cool to  $100^{\circ}$  F.
6. To conform to the acceptance criteria of this procedure, the molded ablator shall meet the following post-cure specifications:
  - (a) The ablator molding shall be heated from  $100^{\circ}$  F to  $300 \pm_{15}^{0}$  F at a uniform rate as indicated by thermocouples No. 1 and No. 2.
  - (b) The temperature of probe thermocouples No. 1 and No. 2 shall be at post-cure temperature for a minimum of 6 hours.
  - (c) The ablator molding shall be oven-cooled from  $300 \pm_{15}^{0}$  F to  $275 \pm_{25}^{0}$  F, as indicated by probe cavity thermocouple No. 1. Remove ablator molding from retort and place in an insulated container. Allow it to cool to room temperature.
7. Remove ablator from insulated box, remove thermocouple leads, and package ablator in a polyethylene bag. Reidentify with embossed aluminum tag on outside of bag.
8. Remove oven program chart and Honeywell-Brown recording chart from recording instruments. Draw a graphical plot of time-temperature curves of each thermocouple plot on a single graph. Identify the graph as form RE9, figure 38. Record on the graph and recording charts the date, job order, formulation batch number, and ablator molding number. Attach graph and charts to form RE6 of this procedure.

#### Post-Cure Density Determination

1. Perform and record density calculations in accordance with paragraphs 1 through 6 under Post Mold Density Determination.
2. Reseal ablator molding in polyethylene bag.



Standard pressure	TRANSDUCER 1		TRANSDUCER 2	
	Up-scale reading	Down-scale reading	Up-scale reading	Down-scale reading
200	200	210	200	200
1,000	990	1,020	1,020	1,020
2,000	2,015	2,060	2,040	2,040
3,000	3,075	3,115	3,060	3,060
4,000	4,075	4,115	4,060	4,060
5,000	5,080	5,120	5,055	5,060
6,000	6,060	6,090	6,035	6,035
7,000	7,060	7,080	7,020	7,030
8,000	8,040	8,055	8,010	8,010
9,000	9,030	9,040	8,990	8,995
10,000	10,000	10,000	9,990	9,990

Standard pressure	TRANSDUCER 3		TRANSDUCER 4	
	Up-scale reading	Down-scale reading	Up-scale reading	Down-scale reading
200	200	200	200	190
1,000	1,035	1,030	950	960
2,000	2,050	2,050	1,905	1,940
3,000	3,080	3,070	2,910	2,960
4,000	4,085	4,075	3,910	3,960
5,000	5,065	5,060	4,940	4,990
6,000	6,045	6,045	5,940	5,990
7,000	7,030	7,045	6,960	7,000
8,000	8,005	8,040	7,930	8,000
9,000	9,020	9,050	8,990	8,985
10,000	9,995	9,995	9,990	9,990

Standard pressure	TRANSDUCER 5		TRANSDUCER 6	
	Up-scale reading	Down-scale reading	Up-scale reading	Down-scale reading
200	200	215	200	190
1,000	1,080	1,065	1,050	1,045
2,000	2,160	2,130	2,095	2,090
3,000	3,190	3,165	3,135	3,130
4,000	4,160	4,140	4,140	4,150
5,000	5,145	5,120	5,140	5,145
6,000	6,140	6,080	6,130	6,125
7,000	7,085	7,055	7,110	7,110
8,000	8,040	8,045	8,080	8,070
9,000	9,010	9,000	9,045	9,045
10,000	9,960	9,960	10,000	10,000

ABLATION NOSE CAP						Molding No. _____
1	2	3	4	5	6	
LRC batch control number	Premold batch total wt. (grams)	Ablator post mold weight (lb)	Post mold diameter (inches)	Post mold thickness (inches)	Post mold volume (ft <sup>3</sup> )	
7	8	9	10	11	12	
Post mold density (lb/ft <sup>3</sup> )	Post cure weight (lb)	Post cure thickness (inches)	Post cure diameter (inches)	Post cure volume (ft <sup>3</sup> )	Post cure density (lb/ft <sup>3</sup> )	
<u>Raw Materials Weight</u>						
25 percent phenolic resin, BRP-5549: _____ grams, MP and DS Material Control No. _____						
40 percent nylon powder, Zytel 103: _____ grams, MP and DS Material Control No. _____						
35 percent phenolic microballoons, BJO-0930: _____ grams, MP and DS Material Control No. _____						
Raw mat. moisture content		Before drying		After drying		
Material type		Sample No. % Moisture		Sample No. % Moisture		
Nylon powder						
Phenolic resin						
Phenolic microballoons						
NOTE: Attach to this form a copy of the following:						
1. Raw Material Sampling Forms for each of the three raw ingredients; reference form RE7.						
2. Graph of Ablator Cure Cycle; reference form RE8.						
3. Graph of Ablator Post Cure Cycle; reference form RE9.						
4. Pressure Transducer Recording Chart for Ablator Molding Cycle.						
5. Temperature Recording Chart for Ablator Molding Cycle.						
6. Temperature Recording Chart for Ablator Post Cure Cycle.						

Form RE6

SCOUT REENTRY HEATING PROJECT

MP and DS Sample Log Sheet

Sample No. \_\_\_\_\_

Material Designation

Manufacturer

Date Received . . . . . \_\_\_\_\_

Batch Number . . . . . \_\_\_\_\_

Lot Number . . . . . \_\_\_\_\_

LRC Order No. . . . . \_\_\_\_\_

MP and DS Purchase Control No. . . . . \_\_\_\_\_

Date Sample Taken . . . . . \_\_\_\_\_

Storage Drum Zone No. . . . . \_\_\_\_\_

Relative Humidity During Sampling . . . . . \_\_\_\_\_

Temperature During Sampling . . . . . \_\_\_\_\_

MP and DS Batch Formulation No. . . . . \_\_\_\_\_

Sample Taken By . . . . . \_\_\_\_\_

Form RE7

Figure 25. Raw Materials Sampling Log

Ablator molding No.	LRC moisture content						Hughes Aircraft samples		
	Mat. batch No.	Nylon		Phen. resin	Microballoons		Nylon	Phen. resin	Micro- balloons
		Not dried	Dried		Not dried	Dried			
1	1	3	A3	1	2	A2	3	1	2
2	2	4	A4	5	6	A6	4	5	6
3	3	7	A7	8	9	A9	7	8	9
4	4	10	A10	11	12	A12	10	11	12
5	5	13	A13	14	15	A15	13	14	15
6	6	16	A16	17	18	A18	16	17	18
7	7	19	A19	20	21	A21	19	20	21
8	8	22	A22	23	24	A24	22	23	24
9	9	25	A25	26	27	A27	25	26	27
10	10	28	A28	29	30	A30	28	29	30
11	11	31	A31	32	33	A33	31	32	33
12	12	34	A34	35	36	A36	34	35	36
13	13	37	A37	38	39	A39	37	38	39
14	14	40	A40	41	42	A42	40	41	42
15	15	43	A43	44	45	A45	43	44	45
16	16	46	A46	47	48	A48	46	47	48
17	17	49	A49	50	51	A51	49	50	51
18	18	52	A52	53	54	A54	52	53	54
19	19	55	A55	56	57	A57	55	56	57
20	20	58	A58	59	60	A60	58	59	60
21	21	61	A61	62	63	A63	61	62	63
22	22	64	A64	65	66	A66	64	65	66
23	23	67	A67	68	69	A69	67	68	69
24	24	70	A70	71	72	A72	70	71	72
25	25	73	A73	74	75	A75	73	74	75
26	26	76	A76	77	78	A78	76	77	78
27	27	79	A79	80	81	A81	79	80	81
28	28	82	A82	83	84	A84	82	83	84
29	29	85	A85	86	87	A87	85	86	87
30	30	88	A88	89	90	A90	88	89	90
31	31	91	A91	92	93	A93	91	92	93
32	32	94	A94	95	96	A96	94	95	96
33	33	97	A97	98	99	A99	97	98	99
34	34	100	A100	101	102	A102	100	101	102
35	35	103	A103	104	105	A105	103	104	105
36	36	106	A106	107	108	A108	106	107	108
37	37	109	A109	110	111	A111	109	110	111
38	38	112	A112	113	114	A114	112	113	114
39	39	115	A115	116	117	A117	115	116	117
40	40	118	A118	119	120	A120	118	119	120
41	41	121	A121	122	123	A123	121	122	123
42	42	124	A124	125	126	A126	124	125	126
43	43	127	A127	128	129	A129	127	128	129
44	44	130	A130	131	132	A132	130	131	132
45	45	133	A133	134	135	A135	133	134	135

Figure 26. Ablator Molding and Materials Sampling  
Numbering Sequence

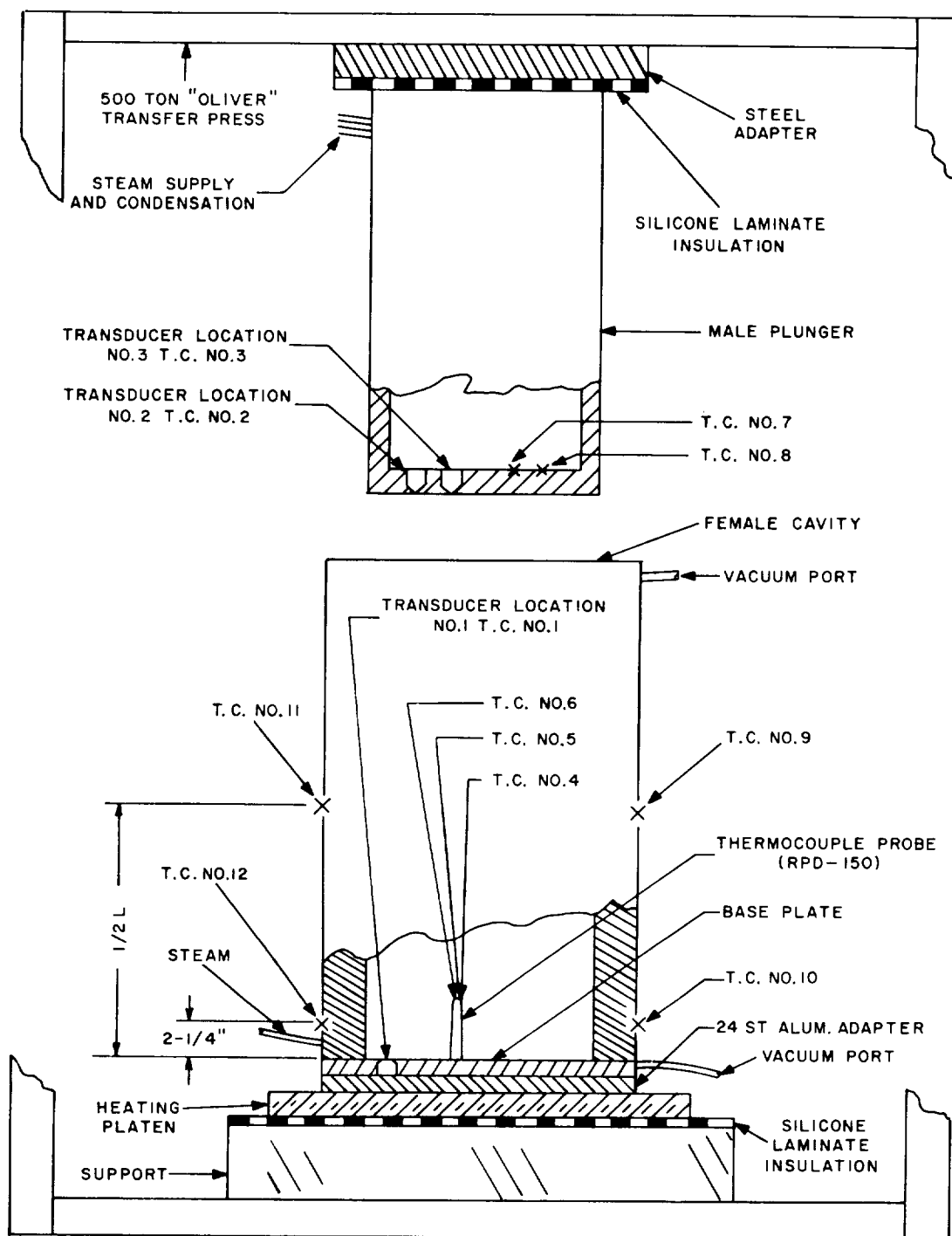
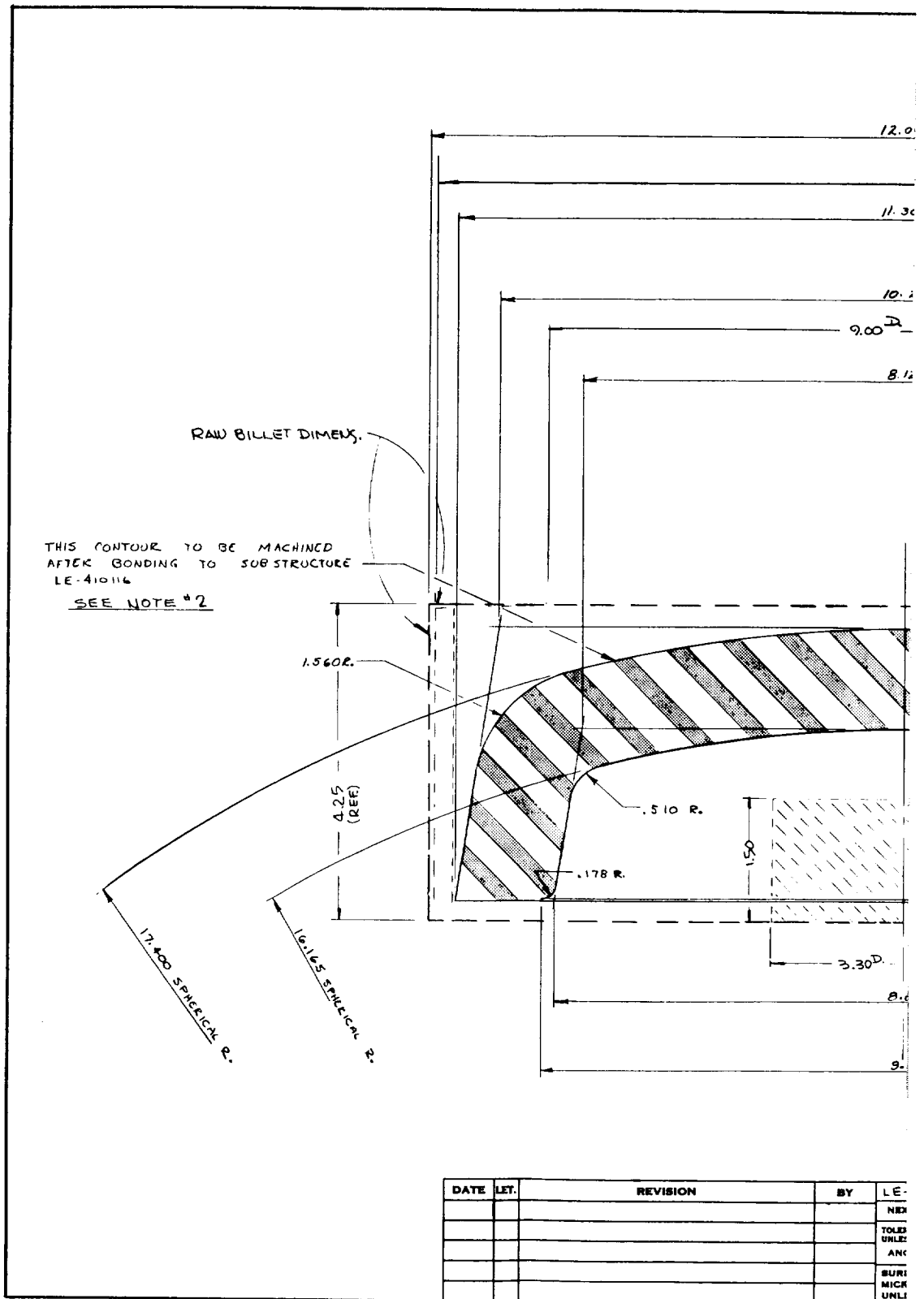


Figure 27. Sketch No. 1. Thermocouple and Pressure Transducer Location









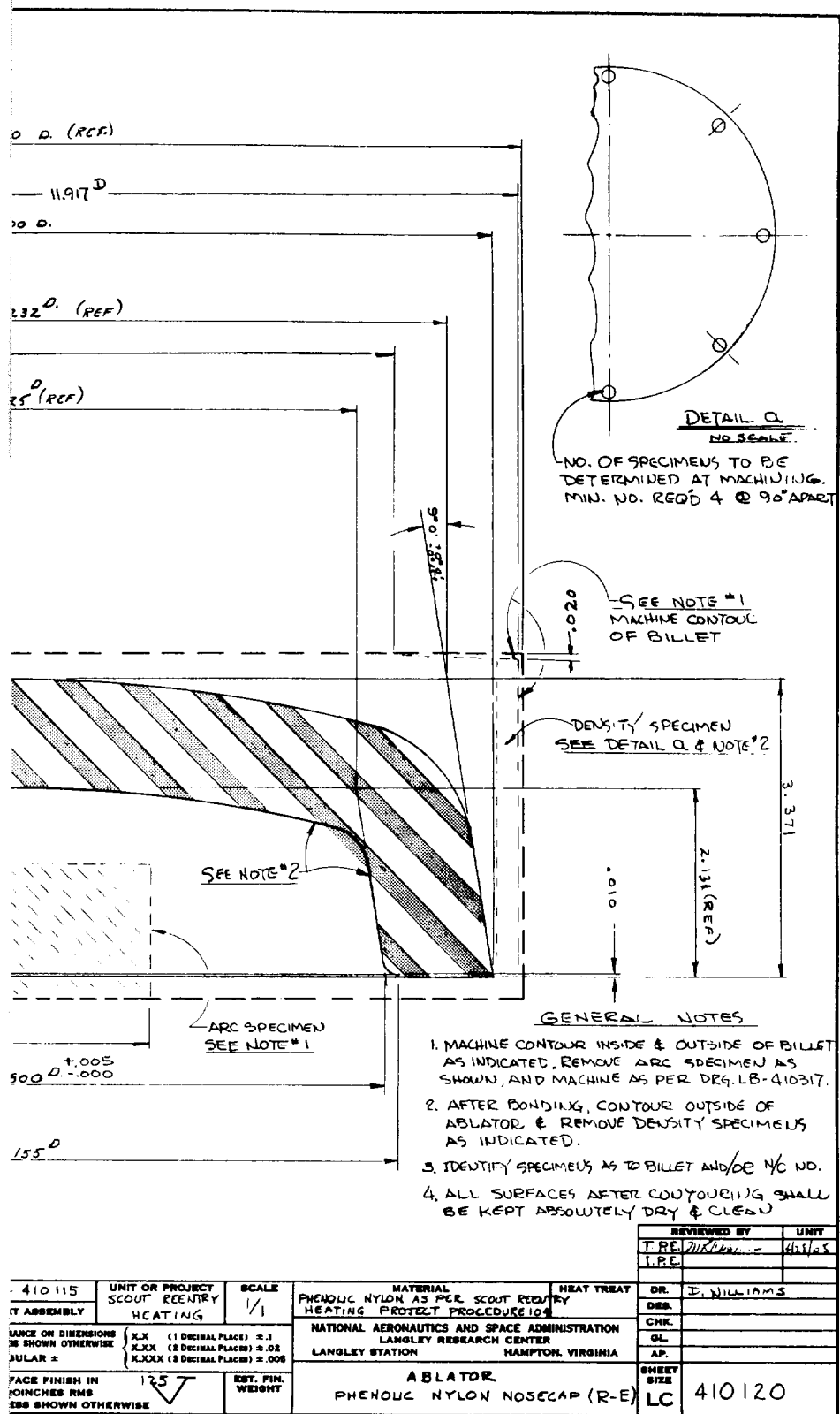


Figure 28. Ablator Contour.

2



## BONDING

### PROCEDURE 105

#### Phenolic Nylon Nosecap

The procedural steps listed below must be followed to assure proper bonding of the ablator to the substructure.

#### 1. Reference Drawings:

- (a) Nosecap assembly dwg No. LX-410115
- (b) Ablator retainer ring, dwg No. LB-410305

#### 2. Materials Required:

- (a) Ablator, LRC dwg No. LD-410120
- (b) Tungsten substructure LRC dwg No. LE-410116
- (c) Adhesive, tape supported, type HT-424, American Cyanamid Company, Bloomingdale Department, MP and DS Control No. B43-13C.727.L66617/C.
- (d) Primer, type HT-424, 30-percent solids, Parts A and B, American Cyanamid Company, Bloomingdale Department, MP and DS Control No. B43-11C.727.L66617/C.
- (e) Thinner, type HT-424, American Cyanamid Company, Bloomingdale Department, MP and DS Control No. B43-14L.727.L66617/C.
- (f) Freon precision cleaning agent, E. I. DuPont.
- (g) Methyleneethylketone solvent, Federal Stock No. 6810-281-2762.
- (h) 1/4-inch-diameter silicone rubber stock.
- (i) 1/16-inch-thick silicone rubber sheet stock, 1/8-inch-thick silicone sponge rubber sheet stock.
- (j) 120-grit aluminum oxide abrasive grain.
- (k) Iron-constantan thermocouple wire, No. 30 gage, certified calibration.
- (l) Powdered asbestos.
- (m) Pressure sensitive teflon tape, 3.5 mils.
- (n) Silicone rubber, RTV-60, G.E. Co.
- (o) DC274 adhesive, Dow-Corning
- (p) Thermoflex felt, Johns-Manville Company.
- (q) Teflon, 12 inches wide, 0.003 inch thick.
- (r) Aluminum foil, soft, 8 mil thick.
- (s) Masking tape, FSN 7510-266-6712

#### 3. Fabrication Equipment Required:

- (a) Blackstone ultrasonic degreaser. Model VR-20-3.
- (b) Press, Stokes Model 727-1, 100-ton capacity, steam-heated platens.
- (c) Honeywell-Brown recorder, 0 - 600° F, iron-constantan.
- (d) Pangborn siphon blast cabinet.

- (e) Hand type blasting gun.
- (f) Shadowgraph scales, Model 4112-HB.
- (g) Oven, air-circulating, 0 - 600°F.

## Bond Line Check Procedure

### NOTE

The ablator, when not being processed, shall be placed in a clean polyethylene bag and stored in an environmental controlled area. The environment of the controlled area shall be as follows:  
Temperature, 7.2° F  
Relative Humidity, 60%  $\pm$ 10

1. Vapor-degrease tungsten substructure in Blackstone vapor degreaser, using freon precision cleaning agent, as follows:
  - (a) Vapor-rinse with distilled freon at 118  $\pm$ 5° F for 5  $\pm$ 1 minutes.
  - (b) Ultrasonic-clean with distilled freon at 105  $\pm$ 5° F for 5  $\pm$ 1 minutes.
  - (c) Vapor-rinse with distilled freon at 118  $\pm$ 5° F for 5  $\pm$ 1 minutes.
2. Cut from 8-mil soft aluminum foil four shims, 1/4-inch square. Position the shims 90-degrees apart on the tapered surface of the tungsten substructure, approximately 1/2-inch from the substructure flange. Tape the shims in place with 3.5-mil teflon tape.
3. Cover the inside contoured ablator surface with 3.5-mil teflon, 1-inch wide, pressure-sensitive tape. Overlap edges of the tape approximately 1/16 inch. Apply tape so that no air is entrapped between it and the ablator surface.
4. Cut from a 1/2-inch aluminum sheet a washer having an inside diameter of 7 inches and an outside diameter of 12 inches. This washer shall be used as the top pressure plate.
5. Cut from a 1/2-inch aluminum sheet a bottom pressure plate, 12 inches square.
6. Place a 1/16-inch-thick, 12-inch-square sheet of silicone rubber on the bottom pressure plate. Position the ablator on top of the silicone sheet.
7. Assemble the substructure in the ablator. Position the top pressure plate (refer to paragraph 4) on top of the substructure.

ture. Dead-weight the assembly with lead shot to ensure intimate contact between shims on substructure and ablator surface.

8. At four points, 90-degrees apart, measure the gap between the top pressure plate and the ablator. Cut from aluminum four suitable-thickness shims. Position these shims on the ablator surface. The shims shall be used as stops during the bond line casting operation. Remove the top pressure plate and substructure from the ablator.
9. Weigh out and mix 100 grams of RTV-60 silicone rubber catalyzed with 1 percent by weight of Thermolite T-12 catalyst.
10. Brush a generous uniform coat of RTV-60 silicone rubber on the bond area surface of the substructure.
11. Assemble the substructure in the ablator. Position the top pressure plate (refer to paragraph 4) on top of the substructure. Lightly clamp the assembly, using "C" clamps, until the top pressure plate lands on the four aluminum stops (refer to paragraph 8).
12. Cure the silicone rubber at 72° F and 58% relative humidity for 16 ±2 hours.
13. Disassemble the substructure from the ablator, and remove the silicone rubber bond line from the substructure. Remove the shims from the substructure and the teflon tape from the ablator.
14. Divide and cut the silicone rubber bond line into eight equal pie-shape segments. Check the thickness of each segment along the cut edge with micrometers. Add 3.5 mils to the micrometer readings to compensate for the teflon tape used on the ablator during casting.
15. The bond line as checked by this method shall be 0.015 ±0.003 of an inch.

#### Tungsten Substructure Surface Preparation

1. Vapor-degrease the substructure in the Blackstone vapor degreaser using freon precision cleaning agent as follows:
  - (a) Vapor-rinse with distilled freon at 118 ±5° F for 5 ±1 minutes.
  - (b) Ultrasonic-clean with distilled freon at 105 ±5° F for 5 ±1 minutes.
  - (c) Vapor-rinse with distilled freon at 118 ±5° F for 5 ±1 minutes.
  - (d) Remove substructure from degreaser and package in a clean polyethylene bag. White cotton gloves shall be worn for this operation and for all subsequent operations performed on the tungsten substructure.

2. Remove the substructure from the polyethylene bag, and mask off all areas outside of bond area with several layers of masking tape.
3. Using a hand-type blasting gun, uniformly blast the exposed bond area of the substructure with 120-grit aluminum oxide abrasive grain using 20-psig line air pressure. The line air to the blasting gun shall be filtered through a water separator to remove all moisture.
4. Remove masking tape. Remove all abrasive residue from surfaces of substructure with a filtered, moisture-free airstream.
5. Vapor-degrease as directed in paragraph 1 above.
6. Within 8 hours after abrasive cleaning operation, prime substructure bond area with HT-424 primer, as follows:
  - (a) Remove HT-424 primer from cold storage and allow it to come up to room temperature.
  - (b) Weigh out equal parts by weight of HT-424 primer, parts A and B, on shadowgraph scales and thoroughly mix, using a clean wooden spatula.
  - (c) Thin the mixed primer with 50-percent by weight of HT-424 primer thinner and thoroughly mix. The mixed primer shall be used within 4 hours after mixing. Store the mixed primer in a sealed container to prevent solvent evaporation.
  - (d) Apply a uniform brush coat of HT-424 primer to the prepared bond area of substructure, lightly brushing during application.
  - (e) Air-dry the primer for  $35 \pm 5$  minutes at room temperature.
  - (f) Apply a second brush coat of primer as in step (d), above, and air-dry as in step (e) above.
  - (g) Place the substructure in a preheated air-circulating oven, and force-dry the primer for  $60 \pm 5$  minutes at  $150 \pm 5^\circ$  F. Cool to  $100^\circ$  F  $\pm 20^\circ$  F and remove from oven.
  - (h) Package the substructure in a polyethylene bag and store at room temperature.

#### Ablator Surface Preparation

1. White cotton gloves shall be worn for all operations while handling the ablator.
2. Clean the contoured interface bond area of the ablator by spray-flushing the surface with distilled freon at  $118 \pm 5^\circ$  F. Dry the ablator in a preheated air-circulating oven at  $125 \pm 10^\circ$  F for  $60 \pm 10$  minutes.

3. Using a hand-type blasting gun, uniformly blast the ablator bond area surface with 120-grit aluminum oxide abrasive grain using 20 psig line air pressure. The line air shall be filtered through a water separator to remove all moisture.
4. Remove all abrasive residue from ablator surfaces with a filtered moisture-free airstream.
5. Prime the ablator surface bond area as given for the substructure.

#### Assembly of Components for Bonding

1. White cotton gloves shall be worn for all assembly operations.
2. Remove the HT-424 adhesive from cold storage and allow it to come up to room temperature.
3. Cut from the adhesive roll a 15-inch diameter disc. Remove the polyethylene backing from one surface. Remove the substructure from the storage bag, and center the exposed adhesive side onto the primed surface of the tungsten substructure. Remove the polyethylene backing from other surface of adhesive film.
4. Carefully fit the adhesive film to the contour of the tungsten substructure, smoothing out all wrinkles and excluding air entrapment between adhesive film and substructure. Trim off excess adhesive film at outside edge of substructure.
5. Install an iron-constantan, No. 30-gage ball junction-type thermocouple, 15 feet long, in each of the four bored holes of the substructure numbered TC No. 19, 3, 5 and 25 (dwg No. LX-410115). To make the installation, slit the HT-424 adhesive film at the center of the hole. Insert the thermocouple lead through the hole from the back face and through the slit. Bend the ball junction to form a 90° angle to the thermocouple wire. Press the ball junction into the surface of the adhesive to hold it in position. Check to ensure that the thermocouple ball of each thermocouple does not extend outside the hole area. Tape the thermocouple to the inside contoured face of the substructure. Thread the free end of the thermocouple through any one of the drilled holes located on, and parallel to, the substructure flange.
6. Spot-weld three No. 30-gage iron-constantan thermocouples 15-feet long, to the tungsten substructure at thermocouple location No. 6, 7, and 8 (reference LRC dwg No. LX-410115). Locate thermocouple No. 6 on the inner surface at the center point of the substructure. Locate thermocouples No. 7 and 8 on the 9.125-inch-diameter surface of the substructure, 180° apart. Thread the free end of thermocouple No. 6 through any one of the

drilled holes located on, and parallel to, the substructure flange. Tape all leads to the substructure with heat-resistant tape. Position the ablator over the tungsten substructure in intimate contact with the adhesive film.

7. Pack powdered asbestos in the holes of the substructure where the thermocouples are located. Fill all other holes through substructure that are covered by the adhesive film with cured silicone rubber stock. Trim the silicone rubber stock approximately 1/4-inch above substructure surface for easy removal after bonding operation.

#### Assembly of Ablator Substructure in Molding Press

1. Position bottom steam platen only in Stokes 100-ton molding press, and hook up steam lines to platen.
2. Position and center the ablator substructure assembly on the heating platen, with the tungsten substructure resting on the bottom heating platen. Slip the ablator retainer ring (reference dwg No. LB-410305) over ablator and shim from bottom platen with wedges, so that it is centered on the ablator; a piece of neoprene rubber must be placed between the wedge and the ablator retainer ring.
3. Lightly tamp 3/8- to 1/2-inch-thick Thermoflex style RF-400 felt, around the periphery of the substructure, in any gap between the substructure and the platen.
4. Cut from 1/8-inch silicone sponge or 1/16-inch nonsponge rubber sheet stock a 12-inch diameter disc. Position the disc on top of exposed surface of ablator.
5. Connect the four bond line control thermocouple leads and the three substructure surface thermocouple leads to the Honeywell-Brown recorder in the following numbering sequence:
  - (a) Thermocouple location No. 19 to channel No. 1.
  - (b) Thermocouple location No. 3 to channel No. 2.
  - (c) Thermocouple location No. 5 to channel No. 3.
  - (d) Thermocouple location No. 25 to channel No. 4.
  - (e) Thermocouple location No. 6 to channel No. 5.
  - (f) Thermocouple location No. 7 to channel No. 6.
  - (g) Thermocouple location No. 8 to channel No. 7.
6. Switch on the Honeywell recorder and check each thermocouple for proper operation.



## Adhesive Cure Cycle

1. Record on the Honeywell-Brown recording chart the following information as it is developed:
  - (a) Date of cure.
  - (b) Time that heat cure cycle starts.
  - (c) Time that adhesive bond reaches  $330 \pm 10^{\circ}$  F.
  - (d) Time that cure time at cure temperature starts.
  - (e) Time that cure time ends.
2. Calculate the load in pounds required to load the bond line area to  $40 \pm 19$  psi. For this calculation, use the reference 9.125-inch-diameter dimension to calculate the area to which the load will be applied. Close the molding press and apply  $40 \pm 10$  pounds per square inch (psi) to the assembly.
3. Raise the bond line temperature, as indicated by the lowest-reading control thermocouple, to  $330 \pm 5^{\circ}$  F in 30 to 120 minutes.
4. Heat the bond line, as indicated by the lowest-reading control thermocouple, to  $340 \pm 10^{\circ}$  F.
5. Cure the adhesive for 1 hour  $\pm 10$  minutes at  $340 \pm 10^{\circ}$  F.
6. Cool the bond line, as indicated by highest-reading control thermocouple, to  $125 \pm_{25}^{00}$  F under pressure with heat off.
7. Remove the bonded assembly from the molding press and disassemble the metal retainer ring. Remove the silicone rubber and thermocouples from the holes in the tungsten substructure.
8. Place the assembly in a clean polyethylene bag and forward to machine shop for contouring of the outer surface in accordance with dwg No. LC-410120.
9. Draw a graphical time-temperature plot of the cure cycle using form RE15. Attach it and the Honeywell-Brown recording chart of the cure cycle to this procedure.

## Moisture Barrier

1. Place the contoured nosecap assembly, substructure side down, on a suitable pedestal to permit free access from all sides.
2. Mix equal portions, by volume, of DC-274 adhesive and toluene.
3. Using a stiff, short bristle brush, apply a uniform coating of the DC-274 adhesive on the nosecap ablator. Allow the adhesive to air-dry for 1 hour.

4. Cut a length of 0.003-inch teflon to cover the circumference of the ablator (approximately 42 inches); then brush a uniform coating of DC-274 adhesive on one side of the teflon, and allow to air-dry for 1 hour.

#### NOTE

When applying teflon to the ablator, it may be stretched slightly to prevent wrinkles; however, over-stretching will cause the teflon to creep after trimming.

5. Carefully place the teflon, adhesive side next to the ablator, around the circumference of the ablator, stretching slightly to prevent wrinkles. Overlap the teflon approximately 2 inches.
6. Using a soft cloth, carefully press the teflon around the side of the ablator and over the radius in such a manner as to prevent wrinkles or the entrapment of air.
7. Trim the teflon at the approximate center of the radius of the ablator.
8. Cut a piece of 0.003-inch teflon approximately 12 x 16 inches, coat one side with the adhesive, and allow it to air-dry for 1 hour.
9. Center the 12 x 16-inch piece of teflon, adhesive side face down, on top of the ablator. Starting at the center of the ablator and using a circular motion, firmly press the teflon to the ablator, progressing outward to the periphery. Stretch the teflon over the radius of the ablator and overlap approximately  $3/4$  inch. Trim excess teflon.
10. Place the teflon-covered ablator on a protected surface. Coat the bottom of the ablator with adhesive and allow to air-dry. Prepare a second piece of teflon as in step 8; when the adhesive has dried, cut an  $8-3/4$ -inch disc from the exact center.
11. Stretch the teflon over the  $9-1/8$ -inch diameter of the substructure and press it onto the ablator. With a soft, pliable, chisel-pointed tool, press the teflon into the corner of the substructure and ablator.
12. Fold the teflon over the ablator edge and overlap approximately  $1/4$  inch. Trim excess teflon and remove all excessive adhesive from the nose cap.
13. A capping strip of prepared teflon,  $1/2$  to  $3/4$ -inch wide, may be placed over the two overlapping seams to assure a tight seal.

## NOSECAP INSTRUMENTATION

### PROCEDURE 106

#### Instrumentation Of Phenolic Nylon Nosecap

The procedural steps required to install the sensing devices in the nose cap are given below.

#### 1. Reference Drawings:

- (a) Nosecap assembly (dwg No. LX-410115) figure 33.
- (b) Spring wire ablation sensor, dwg No. LD-410119
- (c) Optical light pipe ablation sensor, dwg No. LD-410118.
- (d) Thermocouple sensor, dwg No. LD-410117.
- (e) Spacer (dwg No. LB-410123) figure 30.
- (f) Clamp, cable dwg No. LC-410121.
- (g) Retaining washer, (dwg No. LB-410124) figure 22.
- (h) Wiring diagrams, (dwg No. LC-603899) figure 31 and (LC-604108) figure 32,
- (i) Substructure (dwg No. LE-410116) figure 34.

#### 2. Materials Required:

- (a) Ablator (dwg No. LC-410120) bonded to substructure (dwg No. 410116) as shown on assembly dwg No. LX-410115.
- (b) Spring wire sensors.
- (c) Light pipe sensors.
- (d) Thermocouple sensors.
- (e) Cable clamps.
- (f) Retaining washers.
- (g) Spacers.
- (h) CIBA epoxy No. 6005 (Araldite).
- (i) Versamid 140, reactive resin.
- (j) Plaster (quick-setting).
- (k) Plaster form.
- (l) Vinyl tape.
- (m) Hygrograph paper.
- (n) Thermistor, type GB-31J1.
- (o) RTV-102 sealant.
- (p) Isofoam PE-2.
- (q) Shell Epon 931.
- (r) RTV-60.

#### 3. Installation and Test Equipment Required:

- (a) Simpson test set, Model 262.
- (b) Milliammeter, 0.30 ma.
- (c) Depth gage, 0 to 3-in.
- (d) Feeler gage or shims.

- (e) Calipers or pin vise.
- (f) Resistance bridge (Rubicon).
- (g) Cavity inspection tool.
- (h) Micrometers, 0 to 3 inch.
- (i) GO-NO-GO gages, 0.245 through 0.255.
- (j) Hygrograph.
- (k) Precision spacing adapter, 1 inch.

## Preinstallation Procedures and Measurements.

### 1. Measurements

- (a) Using a depth gage and the 1-inch precision spacing adapter, measure the depth("A" dimension) of the thermocouple and light pipe holes on the nose cap. The depth shall be measured from the spot face area of the hole, to the hole bottom, along the center-line axis of the hole. Measure the hole diameter using GO-NO-GO gages. Record all measurements on the fabrication log, form RE4. Refer to dwg No. LX-410115.
- (b) Using a pin vise, measure the depth ("A" dimension) of the spring wire sensor holes. Record these measurements on form RE4, figure 29.
- (c) Using calipers, measure the total nose cap thickness ("C" dimension) at each hole. The measurement shall be made from the spot face area of the hole to the external surface of the ablator, along the center-line axis of the hole only. Record on form RE4.
- (d) Compute the remaining thickness, as the difference between the total thickness and hole depth, from the above measurements and record the result on form RE4 as the "X" dimension.

### 2. Plaster Mold for Nosecap

- (a) Prior to the preinstallation of the sensing devices in the nose cap, it is necessary to protect and support the external surface of the ablator.
- (b) Cover the ablator external surface with vinyl tape.
- (c) Prepare the quick-setting, low-shrink plaster in a form that will fit the nose cap.
- (d) Before the plaster sets, place the vinyl covered ablator into the plaster. Allow the plaster to set up firm.

### 3. Thermocouple Sensor Preparation

- (a) Measure the hole dimensions for hole numbers 3 through 29, and holes 46 and 47, record on form RE1. Compare with the measurements recorded on form RE4.
- (b) Select a thermocouple for hole location No. 3 by comparing the hole depth recorded on form RE1 and the plug length ("L") dimension recorded on form RE11. Measure the plug length and record on form RE1. Compute the washer shim thickness required by subtracting the hole depth from the plug length. Then subtract 0.002 inch from the computed difference and record on form RE11.
- (c) Using the hole diameter recorded on form RE4, compute and record on form RE11 the required plug diameter by subtracting 0.002 inch from the hole diameter.
- (d) Insert the thermocouple sensor, washer shim, protective cap, and form RE11 in a clean envelope and forward to machine shop for grinding.
- (e) Repeat steps (a) through (d) for thermocouple hole locations No. 4 through 29.

### 4. Light Pipe Ablation Sensor Preparation

- (a) Measure and record hole dimension for hole number 42 and record on form RE3-2. Compare with measurements recorded on form RE4.
- (b) Select the appropriate light pipe sensor for hole location No. 42; refer to dwg No. LD-410118. Verify the plug length and diameter by measurement, and record on form RE3. Compute the washer shim thickness by subtracting the hole depth from the plug length; then subtract 0.001 inch and record on form RE3. Grind the shim to this calculated dimension.
- (c) Perform the electrical measurement tests given in Procedure 102, steps 16 and 17. Record the results on form RE3.
- (d) Visually inspect the sensor for evidence of damage.
- (e) Repeat steps (a) through (c) for light pipe sensor holes No. 43 through 45.

## Final Installation

### 1. Spring-Wire Sensor Installation

- (a) Select a spring-wire sensor of a length at least 0.010-inch greater than the depth of the hole in which it will be installed. Verify the sensor length and hole depth by measurement, and record on form RE2-2. Refer to dwg No. LX-410115.
- (b) With the Simpson test set, measure the resistance of the sensor. The resistance shall be  $100K \pm 10K$ . Record this measurement on form RE2-1. Observe polarity of leads.
- (c) Calculate, and record on form RE2-2, the required shim thickness from the difference between the sensor length and the hole depth. Select and use a shim of this size; refer to dwg No. LC-410123.

#### NOTE

The shim shall be nonmetallic to provide insulation between the sensor contacts and the substructure.

- (d) Carefully insert the sensor probe into the hole through the shim and into the ablator. When the sensor is properly bottomed, secure the sensor to the substructure with appropriate mounting hardware.
- (e) Record the sensor serial number and hole location number on form RE2-2.
- (f) Using the Simpson test set, again measure the resistance of the sensor and record on form RE2-1.

### 2. Thermocouple Sensor Installation

- (a) Select the thermocouple and the washer shim machined for hole location No. 19. Verify dimensions by measuring and recording on form RE11.
- (b) Using the Rubicon bridge, measure and record, on form RE-11, the thermocouple resistance. These readings shall be the same as previous measurements  $\pm 1$  percent.
- (c) Apply a thin coat of epoxy bonding agent (CIBA 6005/Versamid 140) to the entire side of the thermocouple, from the shoulder to the face of the plug, being careful not to get any bonding on the thermocouple face.
- (d) Insert the thermocouple into the proper location hole, and press down until the thermocouple bottoms in the hole.

Secure the thermocouple in place with the washer shim and screws, making sure there is slight compression of the thermocouple in the hole when the shim is tightened on the backup structure.

- (e) For additional support, encapsulate the thermocouple leads with RTV-60 after installation.
- (f) Immediately measure and record, on form RE2, the resistances of the thermocouple. These readings shall be the same as previous measurements  $\pm 1$  percent.
- (g) Repeat the steps above for final installation of all subsequent thermocouples.

### 3. Installation of Thermocouple Sensors for Locations 46 and 47.

Thermocouple sensors T/C 46 and 47 were installed in the nose-cap after the installation of all other sensors (light-pipe, spring-wire, and thermocouple) was completed. The procedure used in the installation of thermocouple sensors T/C 46 and 47 is as follows:

- (a) The drilling areas for thermocouples T/C 46 and 47 were located in the nosecaps as shown on drawing No. LX-410115. Obstructing sensor leads were carefully moved and secured to provide safe access for the hole-drilling tool. The drilling areas were masked to prevent drilling chips and residue from entering the remaining instrumentated areas of the nosecap
- (b) The nosecap was secured to the boring-machine drilling jig. A vacuum-cleaning device was positioned adjacent to the drilling area to aid in removing drilling chips. Then the thermocouple location holes were drilled in accordance with drawing No. LX-410115. After drilling was completed, the nosecap was removed from the boring machine and cleaned.
- (c) The holes were then measured and their dimensions recorded on Form RE4. The nosecap was then placed in a protective storage container. Next, photographs were taken of the rear of the nosecap, and x-rays were taken of the new hole sites.
- (d) Thermocouple sensors were selected for installation by utilizing hole-depth dimension "A" as recorded on Form RE4, and plug-length dimension "M" as recorded on Form RE1. Dimension "M" is approximately 0.100-in. greater than the holed depth.
- (e) Utilizing the hole diameters recorded on Form RE4, the plug diameters were computed by subtracting 0.002-in. from the hole diameter, and recorded on Form RE1.

- (f) Using a Rubicon bridge, the thermocouple sensor resistances were measured and recorded on Form RE11.
- (g) A thin coating of epoxy bonding agent (60-percent CIBA 6005, 40-percent Versamid 140) was applied to the entire side of each thermocouple plug from the shoulder to the plug-base. The thermocouple plugs were then pressed into their respective holes until they bottomed. The thermocouples were temporarily secured in place by means of holding clamps.
- (h) The thermocouple resistances were again measured and recorded on Form RE2.
- (i) The exoxy bonding agent was permitted to air-dry at room temperature for 24 hours. The temporary holding clamps were then removed and RTV 102 was applied to the thermocouples to support and secure the cap ends.
- (j) The interconnecting sensor leads were then carefully dressed to and under the cable clamps (refer to dwg No. LX-410115). Photographs and x-rays were then taken of the completed T/C 46 and 47 locations.

#### 4. Light-Pipe Sensor Installation

- (a) Select the light-pipe sensor and washer for hole location No. 42. Verify these dimensions by measurement and record on form RE3-2. Measure the resistance with the Simpson Model 262 on the 10K scale, observing polarity, and record the results on form RE3-1. The results should be the same as those previously recorded.
- (b) Apply a thin coating of Versamid 140/CIBA 6005 to the entire sensor plug length. Make certain that no bonding gets on the face surface of the sensor plug.
- (c) Carefully install the sensor into the proper location hole. Secure the plug in place with the retaining washer and mounting screws.
- (d) With the Simpson Model 262 test-set on the 10K scale, measure the resistance of the sensor. This measurement should be the same as that noted in step (a) above. Record this measurement and note any variation. Observe lead polarity.
- (e) Apply a small amount of RTV-60 to the back of the washer shim and wiring, to support the wiring where it passes through the shim.
- (f) Repeat the steps above for the final installation of all subsequent light pipe sensors.



- (g) Fill void between spot face on backup structure and shoulder of light-pipe sensor with Epon 931.

#### 5. Interconnecting Leads

- (a) Solder wire leads to the spring wire sensors. Connect the common terminals of each spring-wire sensor together and solder to a common lead, in accordance with dwg No. LC-604108.
- (b) Dress all sensor leads under cable clamps and secure. Refer to dwg No. LX-410115.
- (c) Wire the common terminals of the light-pipe sensor together, in accordance with dwg No. LC-604108.
- (d) Color-code the light-pipe and spring-wire sensor leads as follows:

##### Spring Wire Sensors

SW30 - Yellow  
SW31 - Blue  
SW32 - Green  
SW33 - Brown  
SW34 - Red, Yellow  
SW35 - Red, Blue  
SW36 - Red, Green  
SW37 - Red, Brown  
SW38 - Yellow, Blue  
SW39 - Yellow, Green  
SW40 - Yellow, Brown  
SW41 - Blue, Green

SW Common - Red

##### Light Pipe Sensors

LP42 - Black, Yellow, Blue  
LP43 - Black, Red, Yellow  
LP44 - Black, Blue, Green  
LP45 - Black, Green, Brown

LP Common - Black

#### 6. Thermistor Installation

- (a) Install one thermistor at hole location No. 1, and another at hole location No. 2 (reference dwg No. LX-410115), using RTV-102 sealant.

#### 7. Repair and Replacement

- (a) All repairs and/or replacement of any sensing device must be recorded on the back of form RE4. Use the appropriate procedure required for installation when replacement is necessary.

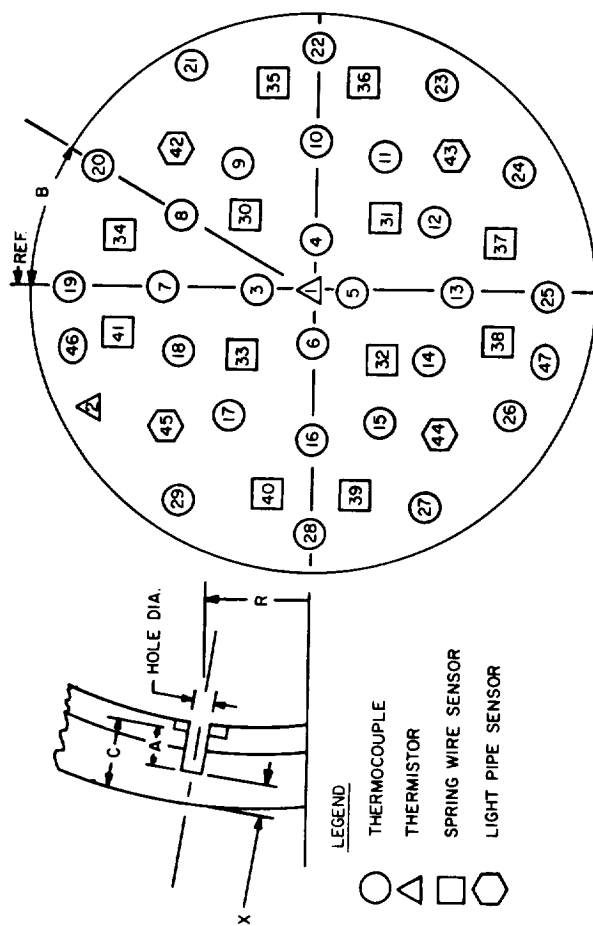
#### 8. Connector Installation

- (a) When all sensors are installed in the nose cap, dress the interconnecting leads under the cable retaining clamps; refer to dwg No. LX-410115.

- (b) Terminate sensor cables with connectors, refer to dwgs No. LC-604108 and LC-603899.

## 9. Encapsulation

- (a) Prepare the nose cap for encapsulation by covering the retaining plate with teflon tape.
- (b) Assemble the retaining plate to the substructure with six screws.
- (c) Mix 50 grams of PE-2 foam (equal parts A and B) for approximately 30 seconds and pour through the vent holes in the retainer plate. Repeat several times until the cavity is filled. Allow the foam to harden approximately 5 minutes between pourings.
- (d) Permit the nose cap to set for one hour at room temperature before removing excess foam and the retainer plate.



NOTE:

The "X" dimensions logged do not include 0.003" for the Teflon moisture barrier

TH No.	Serial No.	A	B Deg	C	B	X	Hole Dia.
1							
2							
T/C							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
46							
47							
S.W							
30							
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							
41							
D/P							
42							
43							
44							
45							

Figure 29. Sensing Devices, Installation and Measurement Log

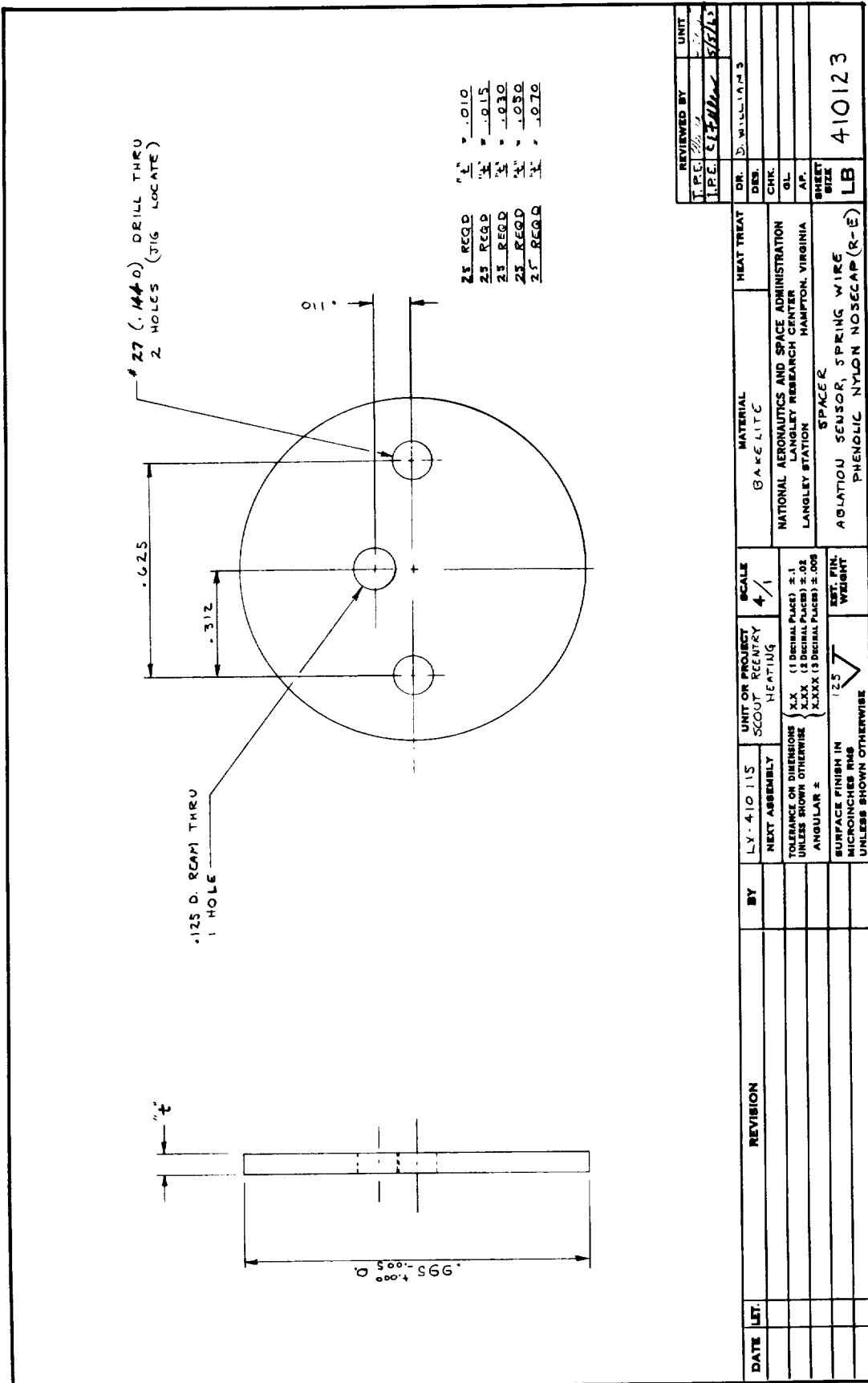
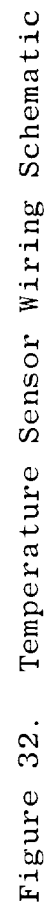


Figure 30. Spring-Wire Ablation Sensor Spacer











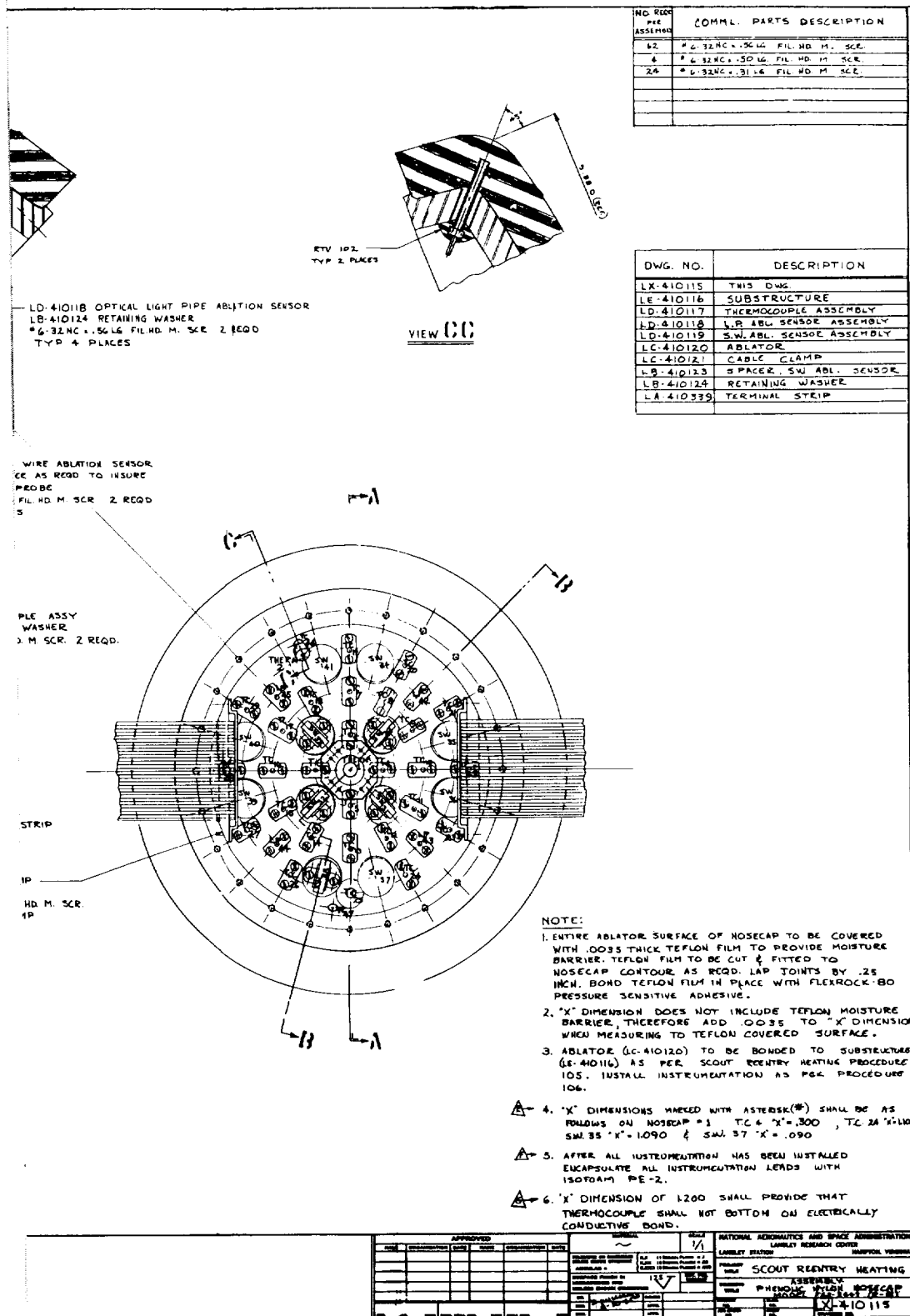
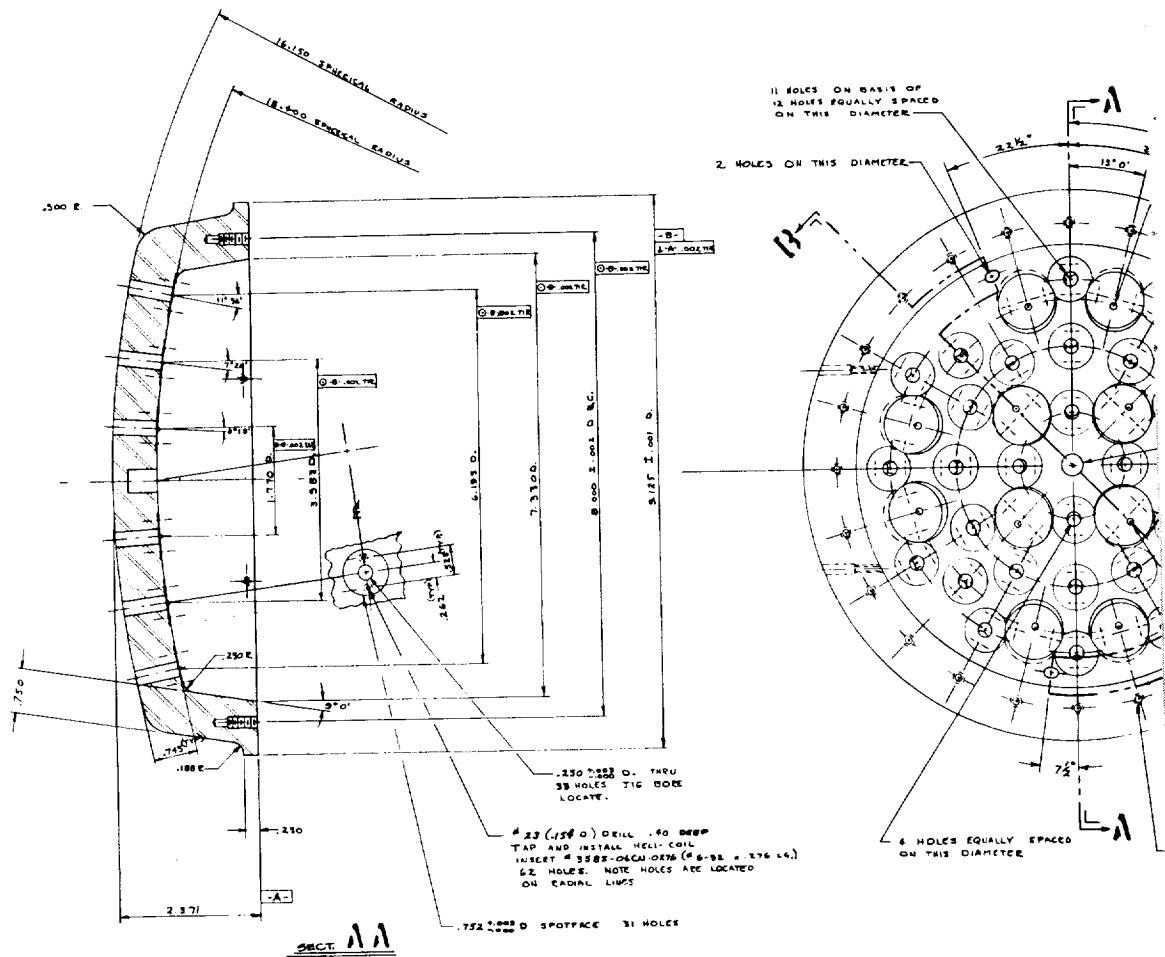


Figure 33. Phenolic Nylon Nosecap Assembly.

2











ARC JET TEST  
PROCEDURE 107

Specimen Assembly

The procedure for performing arc-jet tests on 3-in. ablator material specimens is given below.

1. Reference Drawings:

- (a) Arc-jet specimen, thermocouple (dwg No. LC-410128), figure 36 .
- (b) Arc-jet specimen, plug density variation (dwg No. LD-410271).
- (c) Arc-jet specimen, constant plug density (dwg No. LD-410272).

2. Test Equipment Required:

- (a) LRC 2500-kw arc-jet facility.
- (b) 12-channel Minneapolis-Honeywell Visicorder.
- (c) 18-channel C.E.C. recorder.
- (d) LRC central digital data recording facility.

Sub-sonic Test Procedure

- 1. Install 4-in. nozzle on LRC 2500-kw arc-jet facility.
- 2. Mount the specimen on a water-cooled sting with the face of the specimen 2 inches from exit of arc-jet nozzle.
- 3. Mount a 3-in. diameter flat-faced heat flux calorimeter on a sting with the face of the calorimeter 2 inches from exit of arc-jet nozzle.
- 4. Connect the lead wires from the R-E Scout Project specimen and the calorimeter to the arc-jet junction board.
- 5. Prepare the instrumentation patch-board in accordance with Entry Structures Branch (ESB) procedures.
- 6. Check the electrical continuity of the sensor circuits.
- 7. Turn on the 18-channel C.E.C. recorder for the necessary warm-up period.
- 8. Calibrate the channels being used for recording heat flux on the 12-channel Minneapolis-Honeywell Visicorder.

9. In accordance with ESB procedures, establish the following test conditions:

Heating rate -  $100 + \text{Btu/ft}^2\text{-sec}$   
Stream enthalpy -  $2800 \text{ Btu/lb}$   
Mass flow rate -  $0.35 \text{ lb/sec}$   
Oxygen concentration - 3 percent  
Stream velocity - subsonic  
Voltage tap - 2400  
Power - 1800 kw  
3 reactors - tap 2

Record the test conditions on test data form RE10, figure 35

10. Start the arc-jet facility in accordance with ESB procedures. Request confirmation of proper operation of facility at the required test conditions by ESB Test Coordinator.
11. Insert a calorimeter into the arc-jet stream for heat flux measurement. Allow photographic film from Visicorder to develop with jet operating, and determine the heat flux. If the measured heat flux is not in accordance with the value shown in step 9 above, terminate the test and request ESB Test Coordinator to conduct inspection of the arc-jet facility, calorimeter, and instrumentation.
12. If the measured heat flux conforms to the heat-flux requirement in step 9, insert the test specimen into the arc-jet stream. Terminate the test on command from the Project Engineer.
13. Determine the post-test heat flux in accordance with step 11.
14. Secure the arc-jet facility in accordance with ESB procedures. Remove the test specimen from the water-cooled sting and deliver it to the Project Engineer.

The procedure for performing arc-jet tests on 1-1/2-inch ablator material specimens is given below.

1. Reference Drawings:

Arc-jet specimen - materials performance (dwg No. LB-410317) figure 37.

2. Test Equipment Required:

- (a) LRC 2500 - kw arc-tunnel facility
- (b) LRC central digital data recording facility



## Super-sonic Test Procedures

1. Install supersonic nozzle with 1.500-in. minimum diameter in the 2.0-in. exit on the 2500-kw tunnel facility.
2. Mount the test specimen on a water-cooled sting with the specimen face spaced 0.5-in. from the tunnel nozzle exit.
3. Prepare the instrumentation patch board in accordance with ESB procedures for measuring arc tunnel conditions.
4. Check electrical continuity of sensor circuits.
5. Set the desired test conditions in accordance with ESB calibration procedures. Record the test conditions on test data form RE10 (figure 34).
6. Start the arc-tunnel facility in accordance with ESB procedures. Request confirmation of proper operation of facility at the required test conditions by the ESB Test Coordinator.
7. If visual indication of arc-chamber pressure mass flow rate and tunnel power is in accordance with ESB calibrations, insert the test specimen in the arc tunnel stream. Terminate the test on command from the Project Engineer.
8. Secure the arc-tunnel facility in accordance with ESB procedures. Remove the test specimen from the water-cooled sting and deliver it to the Project Engineer.

Test Date: \_\_\_\_\_ Test Data for Arc Jet Test Sheet No. \_\_\_\_\_

1. Project or test purpose \_\_\_\_\_

2. Arc jet to be used \_\_\_\_\_ Nozzle size \_\_\_\_\_ in. (Use separate  
sheet for each  
Specimen height above the nozzle \_\_\_\_\_ in. nozzle)

3. Approx. No. of runs with specimen \_\_\_\_\_ Duration of  
each run \_\_\_\_\_

4. Approx. No. of calibration runs \_\_\_\_\_ sec.

5. Special equipment to be used:

(a) Oscillograph Yes \_\_\_\_\_ No \_\_\_\_\_

No. of channels \_\_\_\_\_ Arrangement of channels \_\_\_\_\_

Calibration \_\_\_\_\_ M.V. Deflection \_\_\_\_\_ inches

Beckman, number of channels \_\_\_\_\_

(b) Sting: Length \_\_\_\_\_ diam. 7/8 inch \_\_\_\_\_ diam. 3 inch \_\_\_\_\_

(c) Calorimeter: 3/8 inch \_\_\_\_\_ 3 inch flat \_\_\_\_\_  
3 inch hemisphere \_\_\_\_\_

(d) Camera: (1) Fastax \_\_\_\_\_ B and W \_\_\_\_\_ Color \_\_\_\_\_

(2) 16 mm movie \_\_\_\_\_ Frames per sec. \_\_\_\_\_

(3) Field of view \_\_\_\_\_

(e) Other equipment required:

6. \_\_\_\_\_ flow rate required \_\_\_\_\_ lb/sec

7. \_\_\_\_\_ flow rate required \_\_\_\_\_ lb/sec

8. Heating rate required \_\_\_\_\_ Btu/ft<sup>2</sup>-sec

9. Power required \_\_\_\_\_ kw No. reactors \_\_\_\_\_ Top \_\_\_\_\_

-----  
Remarks Tests completed Date

FORM RE10

Figure 35. Arc Jet Test Data



Technical drawing of a specimen cross-section. The drawing shows a central core with a hatched pattern, surrounded by a bond and substrate. Dimensions are indicated on the left and top. Labels point to specific features and details.

Dimensions (from top to bottom):

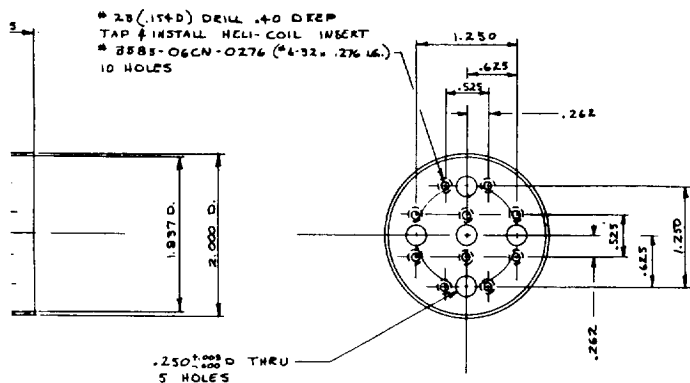
- 2.500 (RCA)
- 2.000
- 2.000
- 2.250 ± .000 D. TYPE 5 PLACES

Labels and Callouts:

- LD-410117 (SPECIMEN TYPE I & II) SEE TABLE
- LD-410118 (SPECIMEN TYPE III) SEE TABLE
- DETAIL (a)
- DETAIL (b)
- .010 BOND B AND SUBSTRUC

[illegible]

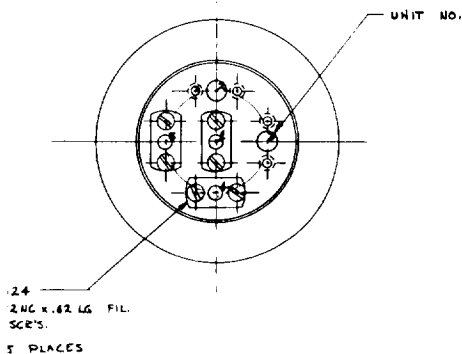




DETAIL (b)  
SUBSTRUCTURE  
MATERIAL: TYPE 304 STAINLESS STEEL

UNIT NO.	SPECIMEN TYPE I			UNIT NO.	SPECIMEN TYPE II		
	DRAWING NO.	"X"	"L" HOLE DEPTH		DRAWING NO.	"X"	"L" HOLE DEPTH
T.C. 1	LD-410117-2	.100	1.900	T.C. 1	LD-410117-17	.250	1.750
2	4	.200	1.800	2	17		
3	3	.300	1.700	3	17		
4	6	.400	1.600	4	17		
T.C. 5	LD-410117-8	.500	1.500	T.C. 5	LD-410117-17	.250	1.750
UNIT NO.	SPECIMEN TYPE III			UNIT NO.	SPECIMEN TYPE IV		
	DRAWING NO.	"X"	"L" HOLE DEPTH		DRAWING NO.	"X"	"L" HOLE DEPTH
T.C. 1	LD-410117-17	.250	1.750	1	DO NOT DRILL THIS HOLE IN ABLATOR		
LP 2	LD-410118-1	.050	1.950	LP 2	LD-410118-4	.200	1.800
3	2	.100	1.900	3	2	.100	1.900
4	3	.150	1.850	4	4	.200	1.800
LP 5	LD-410118-4	.200	1.800	LP 5	LD-410118-3	.150	1.850

ABLATOR  
C NOTE 1



#### NOTE:

- BOND SUBSTRUCTURE TO ABLATOR AS PER SCOUT REENTRY HEATING PROTECT PROCEDURE 105 (HT-424)
- MEASURE AND RECORD "X" AND "L" DIMENSIONS ON FORM PROVIDED IN SCOUT REENTRY HEATING PROTECT PROCEDURE 106

TOTAL 3 TYPE I SPECIMENS REQD.

TOTAL 3 TYPE II SPECIMENS REQD.

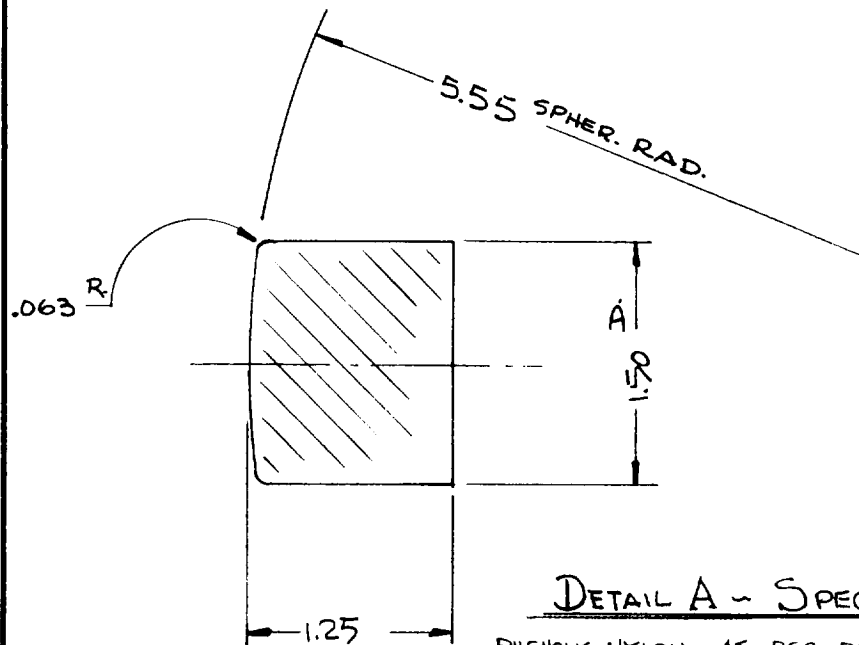
TOTAL 2 TYPE III SPECIMEN REQD.

TOTAL 1 TYPE IV SPECIMEN REQD.

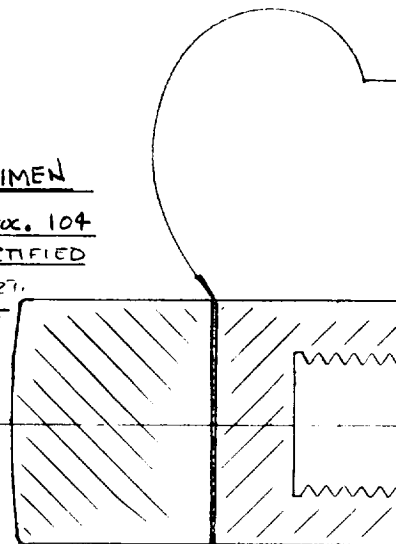
APPROVED						MATERIAL NOTED		SCALE	NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LANGLEY RESEARCH CENTER	
NAME	ORGANIZATION	DATE	NAME	ORGANIZATION	DATE	TOLERANCE ON DIMENSIONS UNLESS SHOWN OTHERWISE		1/2" (1 DECIMAL PLACE) ± .1 1/16" (2 DECIMAL PLACES) ± .02 1/32" (3 DECIMAL PLACES) ± .008	PROJECT TITLE SCOUT REENTRY HEATING	
						SURFACE FINISH IN MICRONS UNLESS SHOWN OTHERWISE		125	DRAWING TITLE SPECIMEN, ARC JET PHENOLIC NYLON NOSECAP (R-E)	
						EST. FINE WEIGHT			PROJECT NO. LD-410128	
4/13/65						DATE		TRIM	DRAWING NO.	

Figure 36. Phenolic Nylon Nosecap Arc-Jet Specimen.





PHENOLIC NYLON AS PER PRG. 104  
 3 REQD CAKE # 9 CERTIFIED  
 3 REQD CAKE # 10 CERT.  
 20 REQD CAKE # 14 CERT  
 4 REQ'D CAKE # 32 UNCERT.  
 4 REQ'D MOLDED AUCOAT -39



DETAIL A

Ass'y

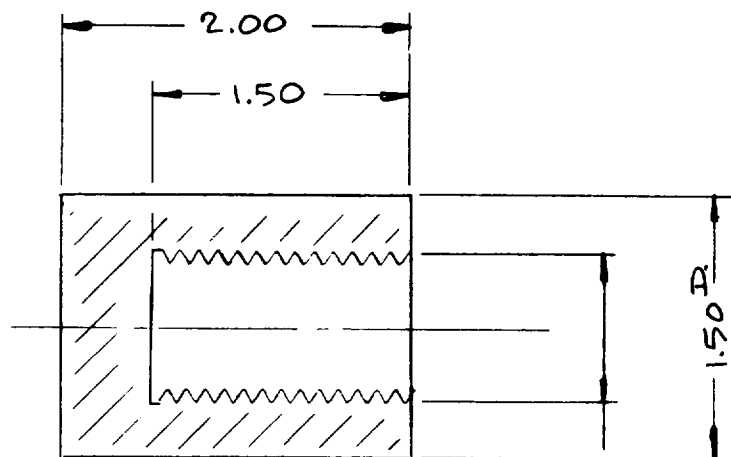
DATE	LET.	REVISION	BY	UNIT
				SCOU
				HE
				NEXT ASSEMBLY
				TOLERANCE ON DIMENSIONS
				UNLESS SHOWN OTHERWISE
				ANGULAR ±
				SURFACE FINISH IN
				MICROINCHES RMS
				UNLESS SHOWN OTHERWISE

1





POW 934  
 SOND LINE

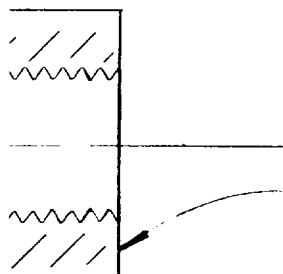


DETAIL B - HOLDER

BAKELITE

34 REQD

$\frac{7}{8}$  - 9 N.C. THD.



NOTE -

EACH SPECIMEN SHALL  
BE IDENTIFIED

DETAIL B

PROJECT REENTRY RING		SCALE ✓	MATERIAL NOTED NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LANGLEY RESEARCH CENTER LANGLEY STATION HAMPTON, VIRGINIA	HEAT TREAT ✓	REVIEWED BY		UNIT
					T.P.E. <i>McWhorter</i>		
(1 DECIMAL PLACE) ±.1 (2 DECIMAL PLACES) ±.02 X (3 DECIMAL PLACES) ±.005					DR.	<i>Parker</i> 21 MAY 65	
					DES.		
					CHK.		
					GL.		
✓		EST. FIN. WEIGHT	SPECIMEN, ARC - MATERIAL PERFORMANCE PHENOLIC NYLON NOSECAP (R-E)	SHEET SIZE LB	410317		
					AP.		

Figure 37. Phenolic Nylon Nosecap Arc Specimen, Material Performance.

2



## FINAL DATA

All mechanical measurements and electrical data for nosecaps No. 1 and No. 2 were recorded on log sheets. These completed logs are made part of this report.

Appendix 1 of this report lists all assembly drawings required for the Reentry E project, and Appendix 2 contains calibration data for correlation with flight telemetry data.

### Ablator

To verify that the ablator material used for the Scout Re-entry Heating Project, Reentry E, had satisfied the requirements of this experiment, the molding process of the billet was carefully monitored. Specimens taken from the billet were subjected to the same arc-jet tests which established material requirements. The in-process checks consisted of monitoring and recording the temperature and pressure of the cure cycle. These checks were plotted on form RE8, figure 38; the post-cure cycle of the ablator was also plotted and is shown in figure 39, for nosecap No. 2.

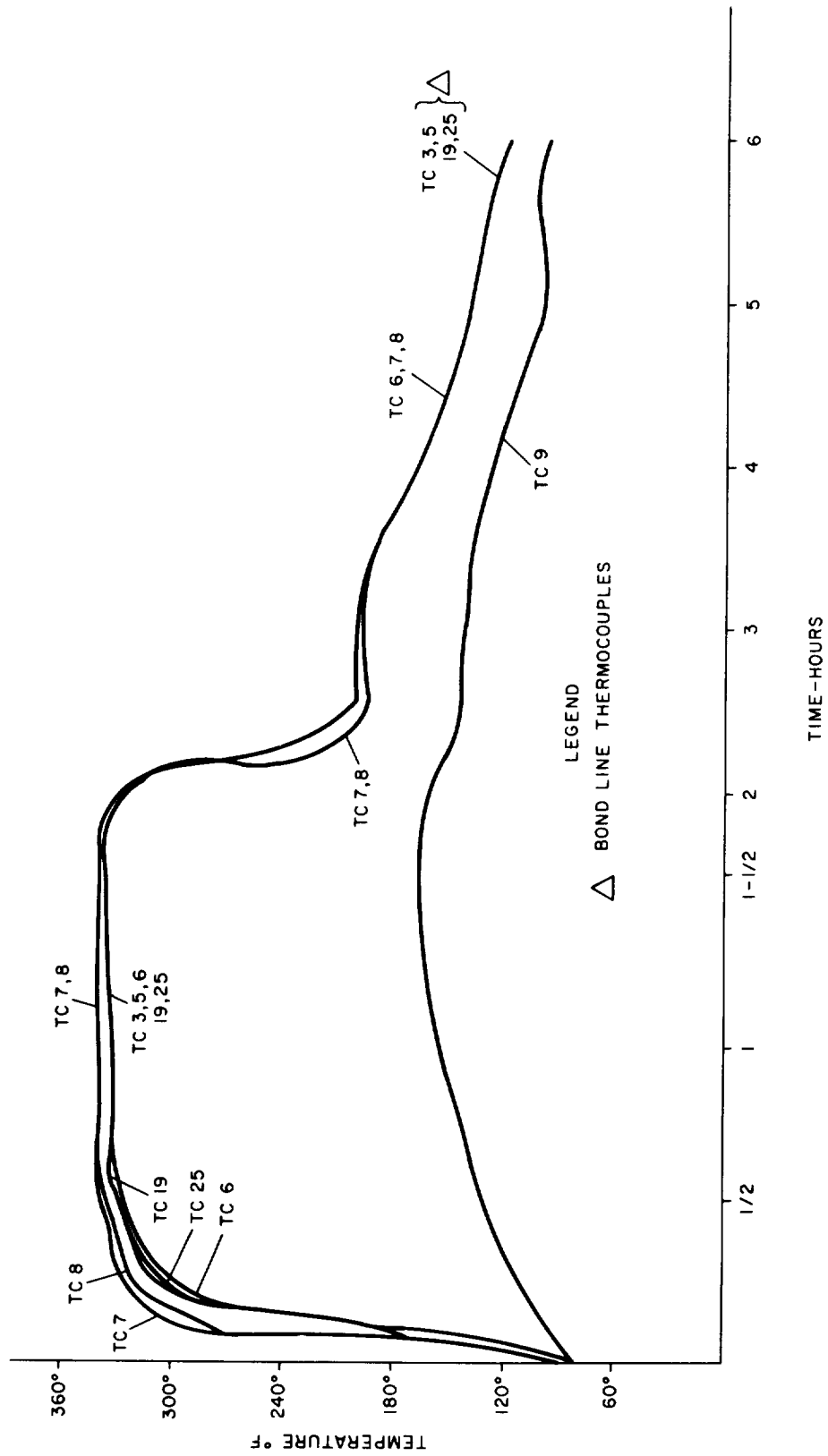


Figure 38. Cure-Cycle Graph, Nosecap No. 2

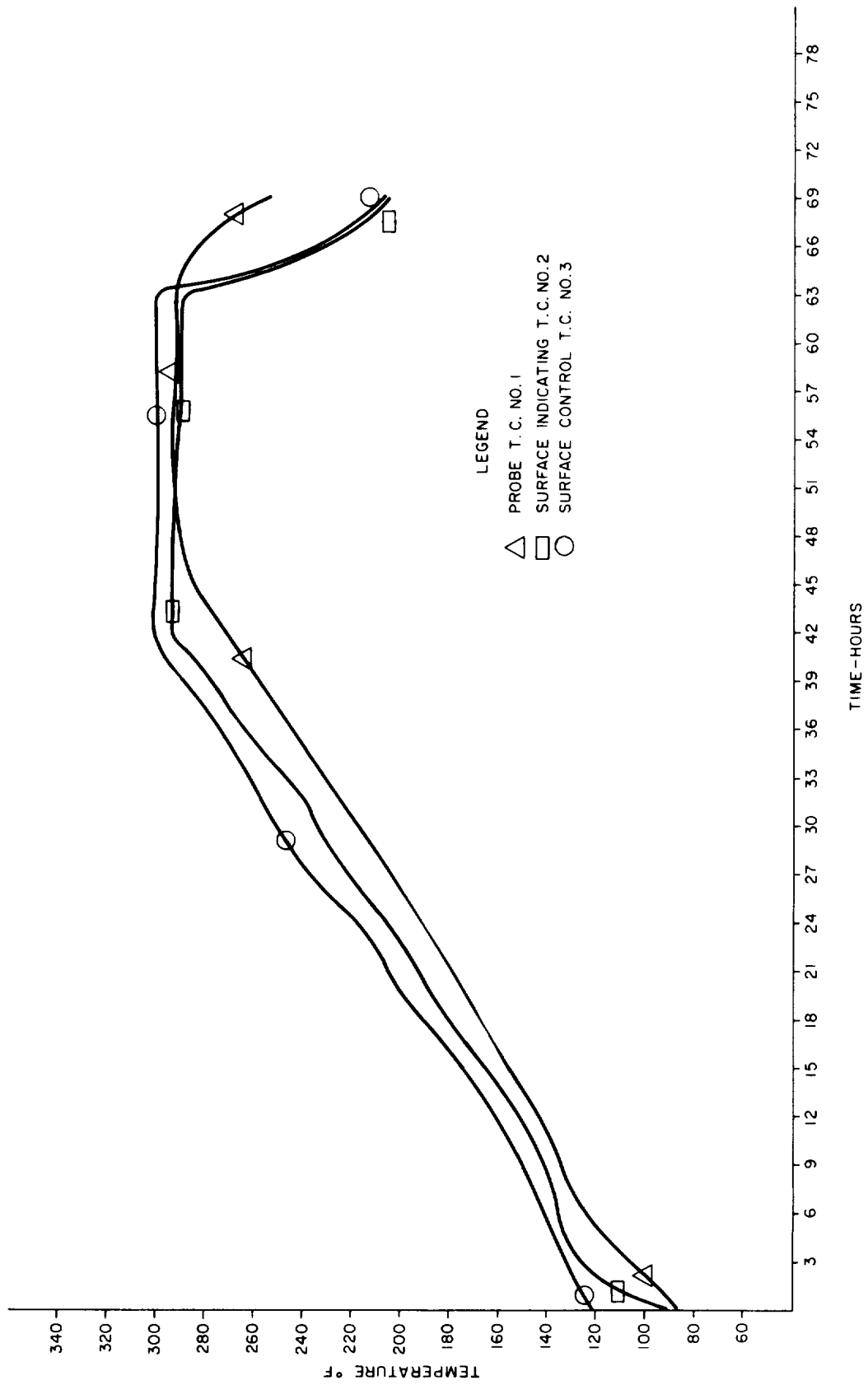


Figure 39. Post-Cure Cycle Graph, Nosecap No. 2

### Bonding

The in-process monitoring of the bonding technique, to assure that a complete and stable bond line had been achieved, was accomplished by monitoring the temperature of the cure cycle. The bond line thickness was controlled as described in Procedure 105. After bonding, the nosecaps were X-rayed to assure a uniform bond. The bond line cure cycle was plotted on form RE5 and is shown in figure 40, for nosecap No. 2.

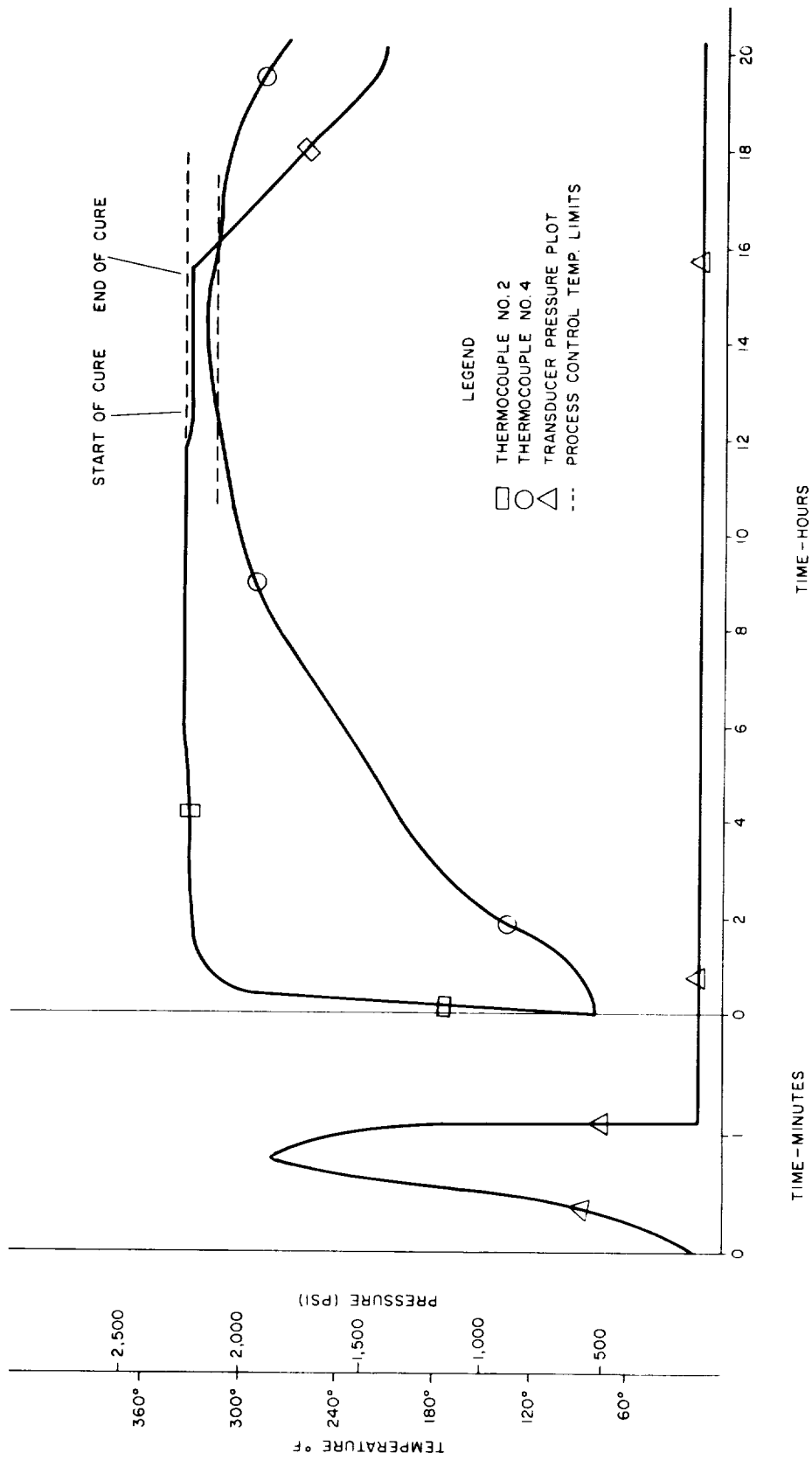
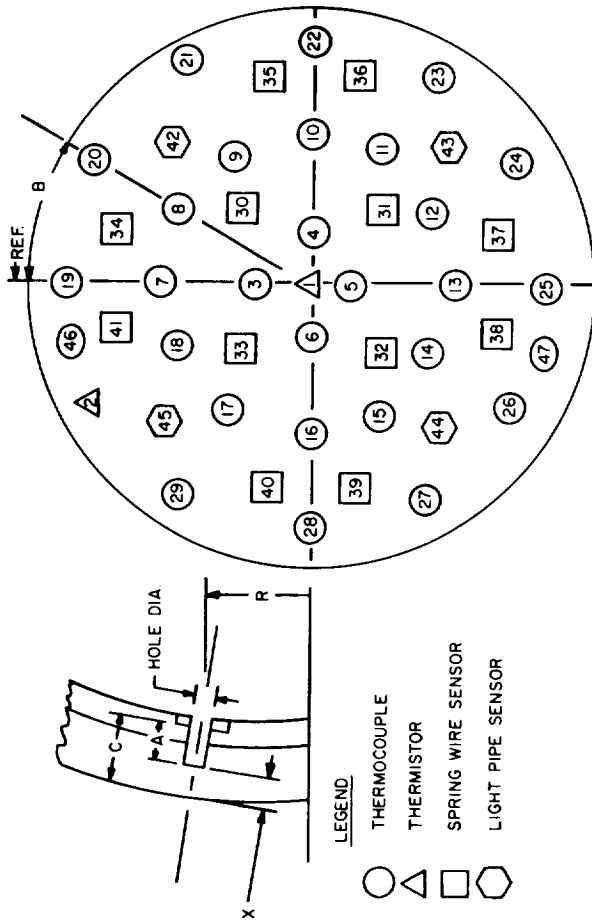


Figure 40. Bonding Graph, Nosecap No. 2



#### Nosecap Subassembly

Machining and drilling of the nose cap subassembly was accomplished in accordance with detailed assembly dwg No. LX-410115. All physical dimensions conformed to the drawing. The sensor mounting holes were measured and verified and were recorded on the fabrication log, form RE4, figure 41.



NOTE:

The "X" dimensions logged do not include 0.003" for the Teflon moisture barrier

TH No.	SERIAL No.	A	B	C	R	X	HOLE DIA.
1	-	.466	0	1.990	0	1.524	.375
2	-	0	330	1.985	3.0795	1.985	-
T/C							
3	NC5-9	1.688	0	1.990	0.885	0.302	0.249
4	NC6-6	1.588	90	1.989	0.885	0.401	0.249
5	NC8-8	1.488	180	1.989	0.885	0.501	0.248
6	NC10-9	1.388	270	1.990	0.885	0.602	0.249
7	NC5-11	1.695	0	1.994	1.9915	0.299	0.249
8	NC4-8	1.794	30	1.994	1.9915	0.200	0.249
9	NC2-10	1.895	60	1.994	1.9915	0.099	0.249
10	NC6-8	1.593	90	1.993	1.9915	0.400	0.249
11	NC13-9	1.091	120	1.993	1.9915	0.902	0.249
12	NC14-3	0.990	150	1.993	1.9915	1.003	0.249
13	NC8-10	1.493	180	1.994	1.9915	0.501	0.249
14	NC12-5	1.193	210	1.994	1.9915	0.801	0.249
15	NC11-6	1.291	240	1.993	1.9915	0.702	0.249
16	NC10-11	1.393	270	1.995	1.9915	0.602	0.249
17	NC15-6	0.890	300	1.992	1.9915	1.102	0.249
18	NC16-3	0.786	330	1.992	1.9915	1.206	0.249
19	NC5-10	1.684	0	1.985	3.0795	0.301	0.249
20	NC2-12	1.889	30	1.986	3.0795	0.097	0.249
21	NC2-13	1.887	60	1.987	3.0795	0.100	0.249
22	NC6-7	1.587	90	1.986	3.0795	0.399	0.249
23	NC13-7	1.084	120	1.986	3.0795	0.902	0.249
24	NC16-2	0.781	150	1.986	3.0795	1.205	0.251
25	NC8-9	1.484	180	1.986	3.0795	0.502	0.249
26	NC4-7	1.789	210	1.988	3.0795	0.199	0.249
27	NC11-5	1.286	240	1.987	3.0795	0.701	0.249
28	NC10-10	1.386	270	1.987	3.0795	0.601	0.249
29	NC12-4	1.184	300	1.985	3.0795	0.801	0.249
46	NC4-10	1.642	337.5	2.143	3.430	0.501	0.249
47	NC7-2	1.443	187.5	2.143	3.430	0.700	0.249
S.W.							
30	122	1.220	45	1.617	1.3275	0.197	0.021
31	126	1.225	135	1.617	1.3275	0.392	0.021
32	128	1.320	225	1.617	1.3275	0.497	0.021
33	124	1.330	315	1.617	1.3275	0.287	0.021
34	123	1.427	15	1.619	2.655	0.192	0.021
35	135	1.532	75	1.620	2.655	0.088	0.021
36	132	0.732	105	1.620	2.655	0.888	0.021
37	131	0.978	165	1.621	2.655	0.743	0.021
38	130	1.481	195	1.621	2.655	0.140	0.021
39	129	1.127	255	1.621	2.655	0.494	0.021
40	127	1.232	285	1.620	2.655	0.388	0.021
41	125	1.326	345	1.618	2.655	0.292	0.021
L.P.							
42	1P 94	1.889	45	1.989	2.655	0.100	0.249
43	1P 93	1.640	135	1.989	2.655	0.349	0.249
44	1P 97	1.538	225	1.990	2.655	0.452	0.249
45	1P 100	1.741	315	1.988	2.655	0.247	0.249

Figure 41. Sensing Devices Installation and Measurement  
Log, Nosecap No. 2

### Spring-Wire Ablation Sensor

During the fabrication of the spring wire sensors, all pertinent mechanical and electrical measurements were recorded on the sensor log sheet, form RE2-2, figure 42. At the time of installation in the nose cap, the hole location number and related data were recorded on the fabrication log, form RE4.

Installed  
Date: 9/1/65

# SPRING-WIRE SENSOR INSTALLATION

NOSECAP NO. 2

Sensor Number	Sensor Length		Hole Number	Total Thickness of Nosecap	Hole Depth	Remaining Thickness "X"	Shim Thickness	Distance Surface to End of Tube	Hole Number
	To End of Tube	To End of Knot							
122	1.494	1.500	30	1.617	1.220	0.197	0.080	0.203	30
123	1.494	1.500	34	1.619	1.427	0.192	0.074	0.199	34
124	1.392	1.395	33	1.617	1.330	0.287	0.066	0.291	33
125	1.396	1.400	41	1.618	1.326	0.292	0.075	0.297	41
126	1.291	1.300	31	1.617	1.225	0.392	0.076	0.402	31
127	1.294	1.303	40	1.620	1.232	0.388	0.072	0.398	40
128	1.195	1.203	32	1.617	1.120	0.497	0.083	0.505	32
129	1.194	1.203	39	1.621	1.127	0.494	0.077	0.504	39
130	1.540	1.547	38	1.621	1.481	0.140	0.067	0.148	38
131	0.944	0.947	37	1.621	0.878	0.743	0.070	0.747	37
132	0.796	0.802	36	1.620	0.732	0.888	0.071	0.895	36
135	1.594	1.600	35	1.620	1.532	0.088	0.069	0.095	35

FORM RE2-2

Figure 42. Spring-Wire Sensor Installation

### Light-Pipe Ablation Sensor

The results of electrical tests and mechanical measurements of the light-pipe ablation sensors after fabrication were recorded on form RE3-2, figure 43. Hole locations in the nosecap and related measurements during installation were recorded on form RE4.

## LIGHT PIPE LOCATION

DATE 10/15/65ASSEMBLY NO. NC No. 2

LIGHT PIPE				ASSEMBLY (MAT'L NO. 13)				WASHER		SENSOR RESISTANCE	
Serial Number	Mat'l No.	"L" Length Measured	"M" Length Measured	Diam. Meas.	Hole Number	Diam. Meas.	Depth Meas.	"X"	Shim Thickness	Pre-Instal- lotion	
										Post Instal- lotion	
94	14C	2.155	1.965	0.247	42	0.249	1.889	0.100	0.265	27.5K	27.5K
93	14C	1.905	1.715	0.248	43	0.249	1.640	0.349	0.264	30.5K	30.5K
97	14C	1.801	1.611	0.248	44	0.249	1.538	0.452	0.262	31.5K	31.75K
100	14C	2.004	1.814	0.247	45	0.249	1.741	0.247	0.262	29.5K	29.5K

Figure 43. Light Pipe Location

FORM RE3-2

### Thermocouple Sensors

Pertinent measurements of individual thermocouple sensors were recorded on form RE1, figure 44. Tests results and mechanical dimensions were recorded on form RE1. Hole location numbers at installation were recorded on form RE4.

## THERMOCOUPLE LOCATION

DATE Sept. 15, 1965

ASSEMBLY NO. NC NO.2

THERMOCOUPLE (MAT'L No.)				ASSEMBLY (MAT'L No. 13)				WASHER	FINAL ELECTRICAL RESISTANCE			
Serial Number	"L" Length Measured	"M" Length Measured	Diam. Meas.	Hole Number	Diam. Meas.	Depth Meas.	"X"	Shim Thickness	Forward	Reverse	Chromel Leakage	Alumel Leakage
15C NC 5-9	1.942	1.752	0.247	3	0.249	1.688	0.302	0.252	19.38	19.38	$\infty$	$\infty$
3C NC 6-6	1.848	1.658	0.247	4	0.249	1.588	0.401	0.258	18.43	18.43		
4C NC 8-8	1.742	1.552	0.246	5	0.248	1.488	0.501	0.252	19.55	19.55		
15C NC10-9	1.646	1.456	0.247	6	0.249	1.388	0.602	0.256	17.84	17.84		
4C NC5-11	1.945	1.755	0.247	7	0.249	1.695	0.299	0.248	18.75	18.75		
15C NC4-8	2.037	1.847	0.247	8	0.249	1.794	0.200	0.241	19.66	19.66		
4C NC2-10	2.144	1.954	0.247	9	0.249	1.895	0.099	0.247	18.64	18.64		
4C NC6-8	1.845	1.655	0.247	10	0.249	1.593	0.400	0.250	19.03	19.03		
4C NC13-9	1.340	1.150	0.247	11	0.249	1.091	0.902	0.247	Spare			
4C NC14-3	1.240	1.050	0.247	12	0.249	0.990	1.003	0.248	18.42	18.42		
4C NC8-10	1.745	1.555	0.247	13	0.249	1.493	0.501	0.250	19.87	19.87		
3C NC12-5	1.444	1.254	0.247	14	0.249	1.193	0.801	0.249	20.56	20.56		
3C NC11-6	1.537	1.347	0.247	15	0.249	1.291	0.702	0.244	20.81	20.81		
15C NC10-11	1.638	1.448	0.247	16	0.249	1.393	0.602	0.243	20.52	20.52	$\rightarrow$	$\downarrow$

FORM RE1

Figure 44. Thermocouple Location (Sheet 1 of 2)



## THERMOCOUPLE LOCATION

DATE Sept. 15, 1965

ASSEMBLY NO. NC NO. 2

THERMOCOUPLE (MAT'L No.)		ASSEMBLY (MAT-L No. 13)				WASHER	FINAL ELECTRICAL RESISTANCE					
Serial Number	"L" Length Measured	"M" Length Measured	Diam. Meas.	Hole Number	Diam. Meas.	Depth Meas.	"X"	Shim Thickness	Forward	Reverse	Chromel Leakage	Alumel Leakage
15C NC15-6	1.139	0.949	0.247	17	0.249	0.890	1.102	0.247	21.13	21.13	∞	∞
3C NC16-3	0.995	0.805	0.247	18	0.249	0.786	1.206	0.207	19.75	19.75		
15C NC5-10	1.937	1.747	0.247	19	0.249	1.684	0.301	0.251	19.99	19.99		
4C NC2-12	2.140	1.950	0.247	20	0.249	1.889	0.097	0.249	spare			
4C NC2-13	2.142	1.952	0.247	21	0.249	1.887	0.100	0.253	19.73	19.73		
3C NC6-7	1.845	1.655	0.247	22	0.249	1.587	0.399	0.256	21.00	21.00		
4C NC13-7	1.345	1.155	0.247	23	0.249	1.084	0.902	0.259	17.84	17.84		
3C NC16-2	0.987	0.797	0.249	24	0.251	0.781	1.205	0.204	18.66	18.66		
4C NC8-9	1.743	1.553	0.247	25	0.249	1.484	0.502	0.257	19.30	19.30		
15C NC4-7	2.044	1.854	0.247	26	0.249	1.789	0.199	0.253	20.73	20.73		
3C NC11-5	1.536	1.346	0.247	27	0.249	1.286	0.701	0.248	17.19	17.19		
15C NC10-10	1.640	1.450	0.247	28	0.249	1.386	0.601	0.252	15.51	15.51		
3C NC12-4	1.445	1.255	0.247	29	0.249	1.184	0.801	0.259	spare			
4C NC4-10	2.045	1.855	0.247	46	0.249	1.642	0.501	N/A	17.60	17.60		
3C NC7-2	1.788	1.598	0.247	47	0.249	1.443	0.700	N/A	18.52	18.52	↘	↘

BACKUP NOSECAP NO. 1 FINAL DATA

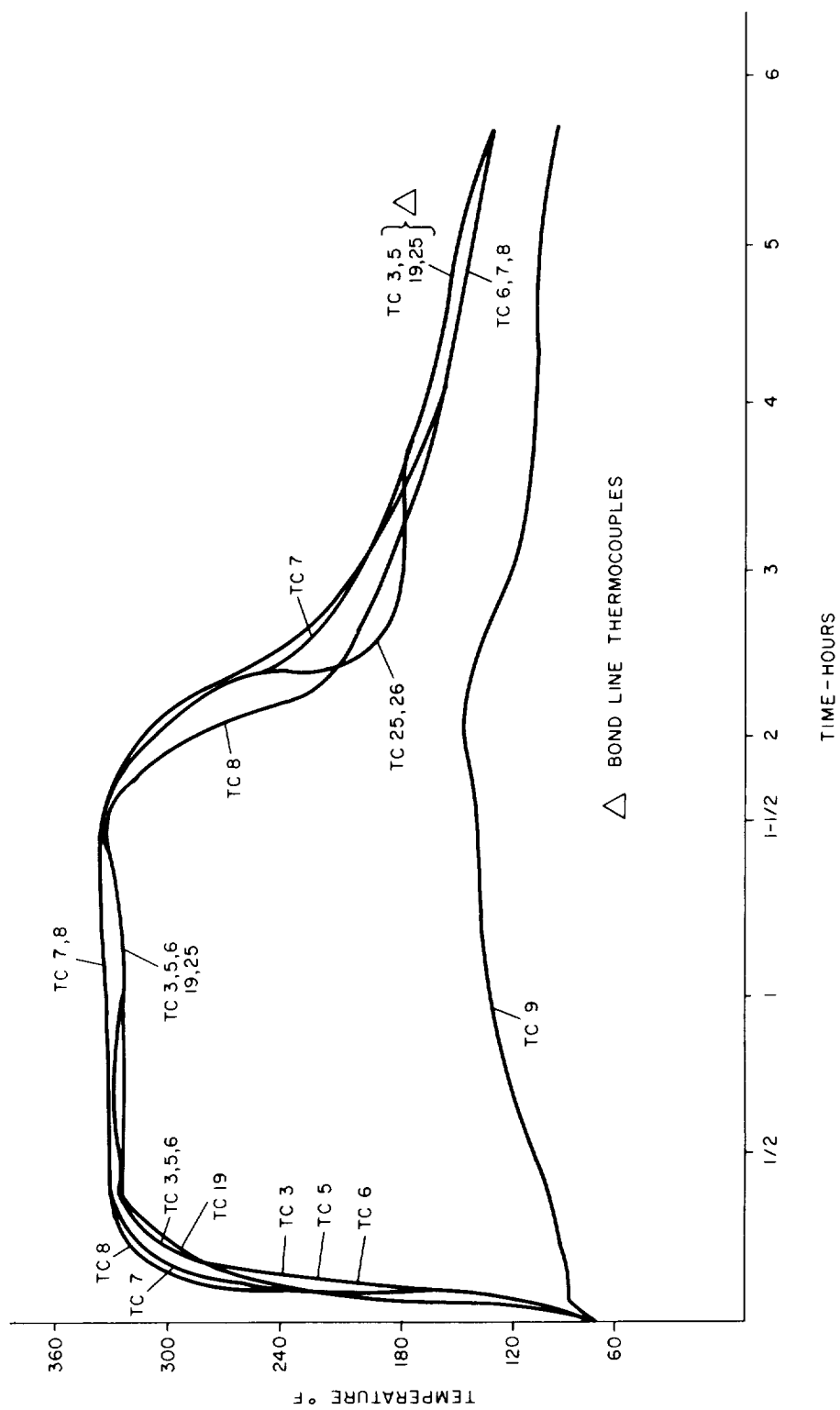


Figure 45. Cure-Cycle Graph, Nosecap No. 1

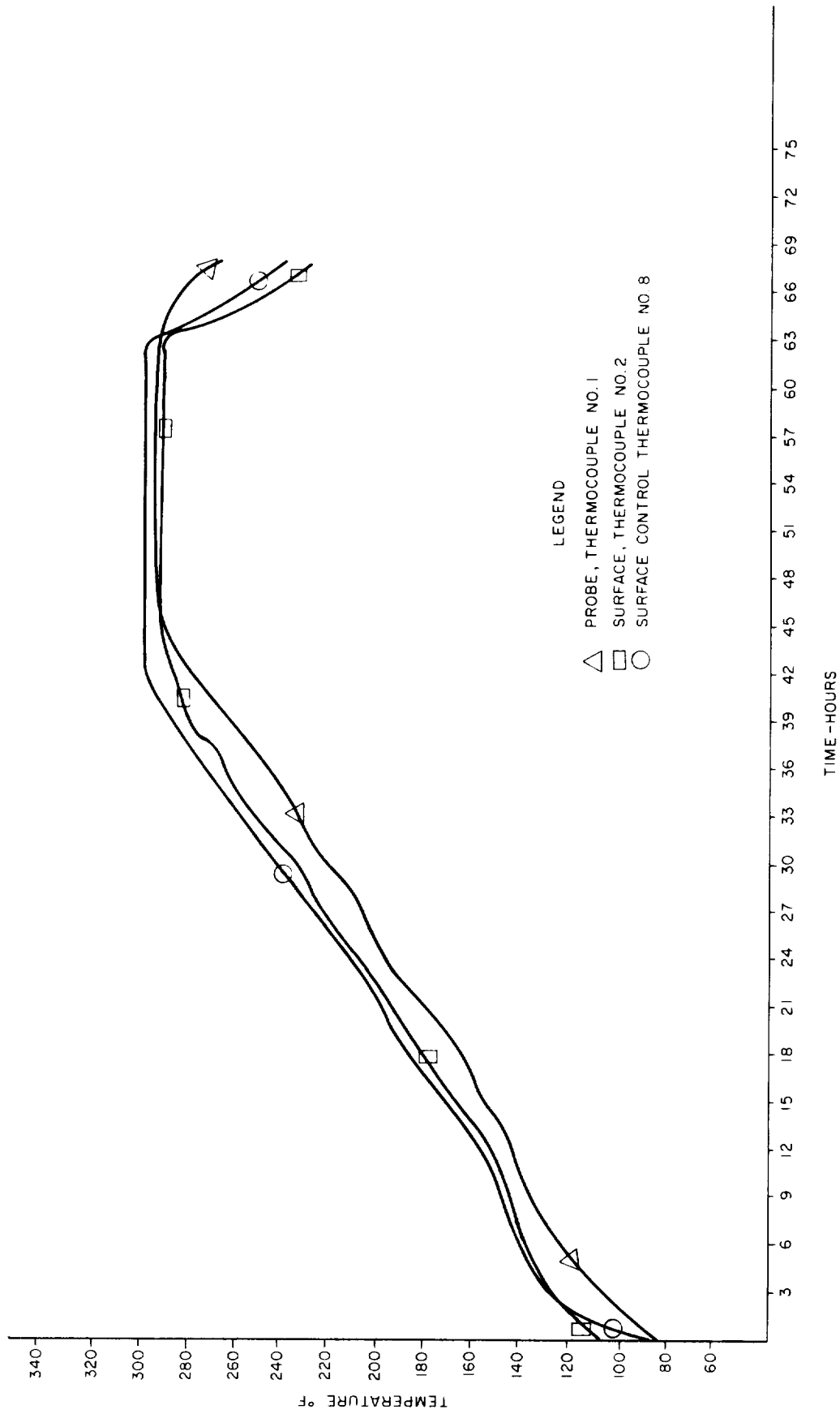


Figure 46. Post-Cure Cycle Graph, Nosecap No. 1

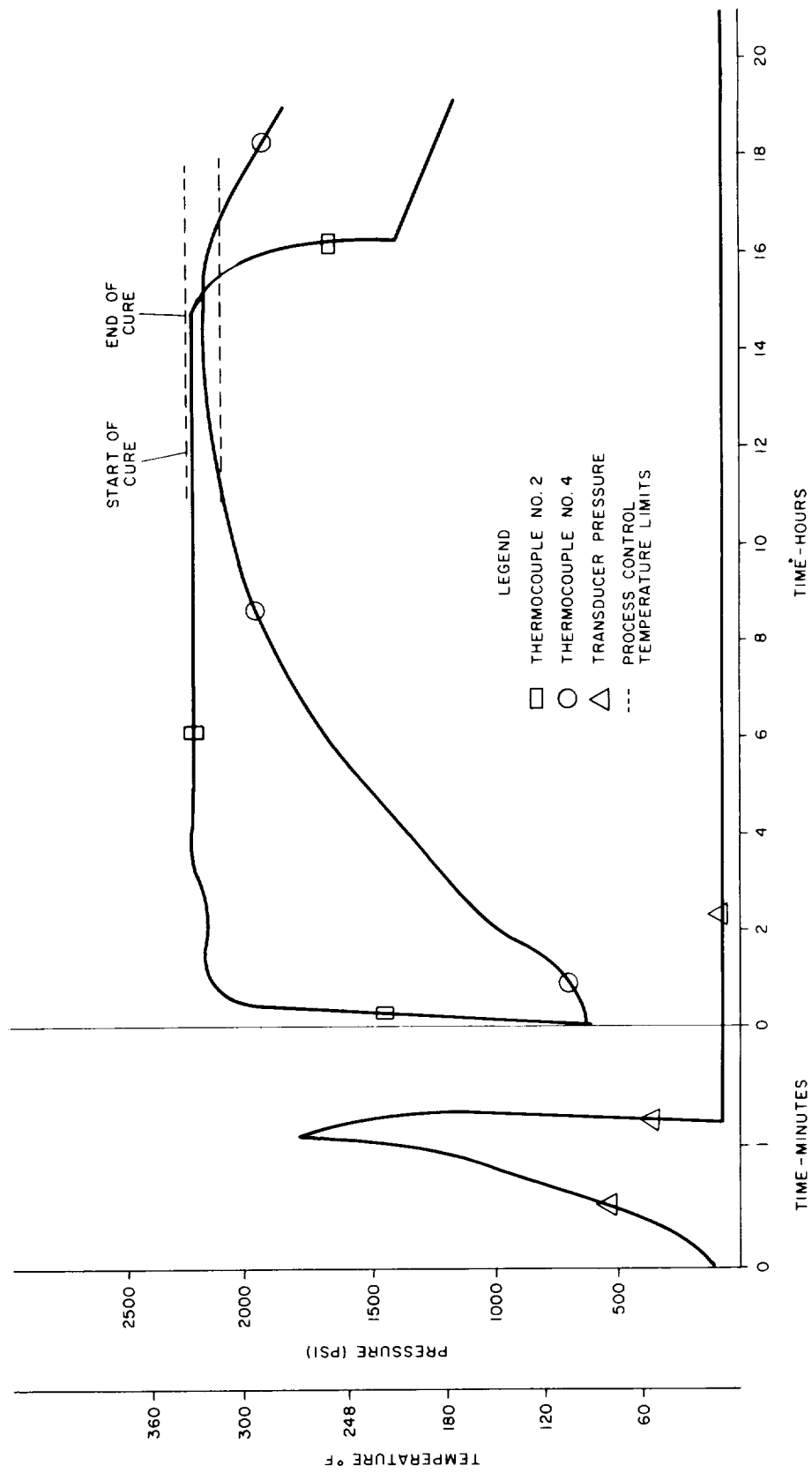
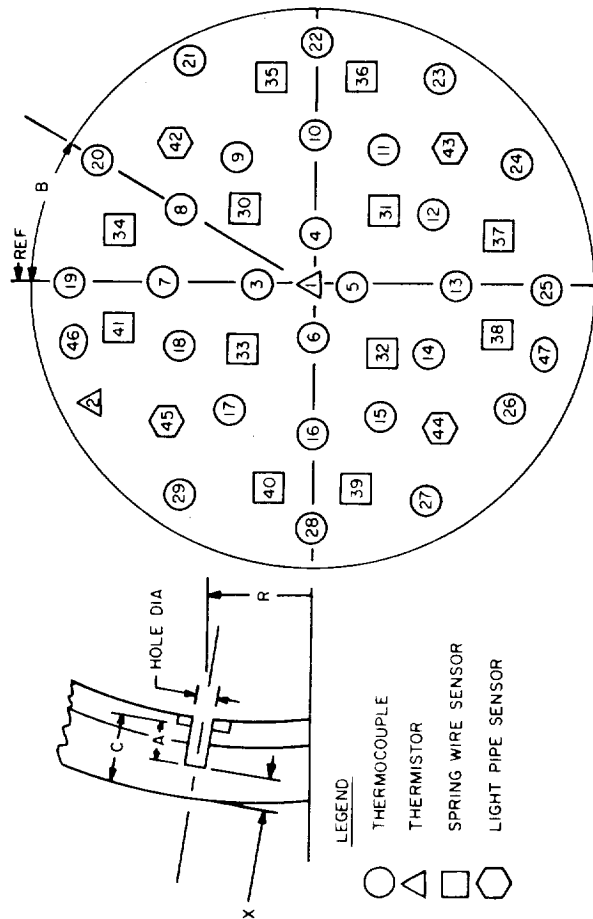


Figure 47. Bonding Graph, Nosecap No. 1



NOTE:

The "X" dimensions logged do not include 0.003" for the Teflon moisture barrier

TH No.	SERIAL No.	A	B	C	R	X	HOLE DIA.
1	-	0.466	0	2.005	0	1.539	0.245
2	-	0	330	2.015	3.0795	2.012	-
T/C							
3	NC5-6	1.210	0	2.004	0.585	0.291	0.248
4	NC5-5	1.703	90	2.004	0.585	0.301	0.248
5	NC8-6	1.508	180	2.003	0.585	0.495	0.248
6	NC10-7	1.403	270	2.004	0.585	0.601	0.248
7	NC5-7	1.710	0	2.010	1.9915	0.309	0.248
8	NC4-6	1.810	30	2.010	1.9915	0.290	0.248
9	NC2-4	1.909	60	2.008	1.9915	0.099	0.242
10	NC2-4	1.608	90	2.009	1.9915	0.401	0.242
11	NC13-6	1.108	120	2.009	1.9915	0.901	0.248
12	NC14-2	1.009	150	2.010	1.9915	1.003	0.248
13	NC8-4	1.511	180	2.008	1.9915	0.427	0.247
14	NC12-1	1.212	210	2.010	1.9915	1.164	0.249
15	NC11-4	1.309	240	2.010	1.9915	0.721	0.245
16	NC10-6	1.408	270	2.010	1.9915	0.602	0.248
17	NC15-4	0.907	300	2.010	1.9915	1.233	0.247
18	NC15-5-1	0.845	330	2.009	1.9915	1.164	0.249
19	NC5-8	1.721	0	2.015	3.0795	0.294	0.248
20	NC3-7	1.912	30	2.013	3.0795	0.131	0.248
21	NC2-6	1.916	60	2.012	3.0795	0.096	0.247
22	NC6-5	1.616	90	2.013	3.0795	0.397	0.247
23	NC13-4	1.111	120	2.011	3.0795	0.900	0.248
24	NC15-5	0.911	150	2.012	3.0795	1.103	0.249
25	NC8-7	1.516	180	2.012	3.0795	0.496	0.247
26	NC4-5	1.813	210	2.012	3.0795	0.199	0.248
27	NC11-4	1.318	240	2.013	3.0795	0.695	0.247
28	NC10-8	1.413	270	2.013	3.0795	0.600	0.247
29	NC12-3	1.214	300	2.014	3.0795	0.800	0.248
46	NC4-7	1.662	337.5	2.102	3.430	0.500	0.249
47	NC7-1	1.461	167.5	2.103	3.430	0.702	0.249
S.W.							
30	1P-99	1.455	45	1.638	1.3275	0.193	0.021
31	1P-13	1.245	135	1.638	1.3275	0.393	0.021
32	1P-17	1.143	225	1.636	1.3275	0.493	0.021
33	1P-11	1.344	315	1.637	1.3275	0.293	0.021
34	1P-10	1.443	15	1.636	2.655	0.193	0.021
35	1P-12	0.543	75	1.636	2.655	0.293	0.021
36	1P-10	0.443	105	1.636	2.655	0.293	0.021
37	1P-9	1.542	165	1.635	2.655	0.090	0.021
38	1P-13	1.491	195	1.634	2.655	0.140	0.021
39	1P-16	1.151	255	1.636	2.655	0.493	0.021
40	1P-14	1.243	285	1.636	2.655	0.393	0.021
41	1P-12	1.343	345	1.636	2.655	0.293	0.021
L.P.							
42	1P-99	1.910	45	2.112	2.655	0.102	0.248
43	1P-98	1.661	135	2.101	2.655	0.352	0.248
44	1P-90	1.558	225	2.099	2.655	0.451	0.249
45	1P-91	1.762	315	2.102	2.655	0.250	0.250

Figure 48. Sensing Devices Installation and Measurement  
Log, Nosecap No. 1

Installed  
Date: 8/2/65

# SPRING-WIRE SENSOR INSTALLATION

NOSECAP NO. 1

Sensor Number	Sensor Length		Hole Number	Total Thickness of Nosecap	Hole Depth	Remaining Thickness "X"	Shim Thickness	Distance Surface to End of Tube	Hole Number
	To End of Tube	To End of Knot							
109	1.498	1.503	30	1.635	1.445	0.190	0.063	0.200	30
110	1.497	1.503	34	1.633	1.443	0.190	0.063	0.199	34
111	1.393	1.398	33	1.634	1.344	0.290	0.058	0.299	33
112	1.395	1.401	41	1.633	1.343	0.290	0.061	0.299	41
113	1.296	1.305	31	1.635	1.245	0.390	0.063	0.402	31
114	1.296	1.300	40	1.633	1.243	0.390	0.061	0.398	40
116	1.195	1.203	39	1.633	1.143	0.490	0.062	0.500	39
117	1.203	1.208	32	1.633	1.143	0.490	0.068	0.498	32
118	1.540	1.545	38	1.631	1.491	0.140	0.055	0.146	38
119	0.590	0.599	37	1.632	1.542	0.090	0.057	0.099	37
120	0.794	0.798	36	1.633	0.743	0.890	0.058	0.897	36
121	0.595	0.603	35	1.633	0.543	1.090	0.063	1.101	35

FORM RE2-2

Figure 49. Spring-Wire Sensor Installation

## LIGHT PIPE LOCATION

DATE Aug. 17, 1965ASSEMBLY NO. NC No. 1

LIGHT PIPE (MAT'L NO. 14C)				ASSEMBLY (MAT'L NO. 10C)					WASHER	SENSOR RESISTANCE	
Serial Number	Mat'l No.	"L" Length Measured	"M" Length Measured	Diam. Meas.	Hole Number	Diam. Meas.	Depth Meas.	"X"	Shim Thickness	Pre-Instal-lation	Post Instal-lation
LP 99	14	2.154	1.964	0.248	42	0.248	1.910	0.102	0.243	29 K	29 K
98	14	1.906	1.716	0.248	43	0.248	1.661	0.352	0.244	33 K	31.5 K
90	14	1.808	1.618	0.249	44	0.249	1.558	0.451	0.249	35 K	33.25K
91	14	2.004	1.814	0.250	45	0.250	1.762	0.250	0.241	33.5 K	31.5 K

Figure 50. Light Pipe Location

FORM RE3-2



## THERMOCOUPLE LOCATION

DATE Aug. 17, 1965

ASSEMBLY NO. NC No. 1

THERMOCOUPLE (MAT'L No.)				ASSEMBLY (MAT'L No. 10C)				WASHER	FINAL ELECTRICAL RESISTANCE			
Serial Number	"L" Length Measured	"M" Length Measured	Diam. Meas.	Hole Number	Diam. Meas.	Depth Meas.	"X"	Shim Thickness	Forward	Reverse	Chromel Leakage	Alumel Leakage
3C NC 5-6	1.942	1.752	0.246 0.248	3	0.248	1.710	0.294	0.230	19.86	19.86	∞	∞
3C NC 5-5	1.944	1.754	0.249	4	0.248	1.703	0.301	0.239	18.37	18.37		
3C NC 8-6	1.742	1.552	0.248	5	0.248	1.508	0.495	0.232	19.35	19.35		
4C NC10-7	1.644	1.454	0.247- 0.248	6	0.248	1.403	0.601	0.239	19.80	19.80		
3C NC 5-7	1.943	1.753	0.247- 0.249	7	0.248	1.710	0.300	0.231	21.15	21.15		
15C NC 4-6	2.042	1.852	0.249- 0.2495	8	0.248	1.810	0.200	0.230	20.06	20.06		
3C NC 2-4	2.146	1.953	0.247- 0.249	9	0.249	1.909	0.099	0.235	18.87	18.87		
3C NC 6-4	1.843	1.653	0.246- 0.247	10	0.247	1.608	0.401	0.233	18.45	18.45		
3C NC13-6	1.347	1.157	0.248- 0.2485	11	0.248	1.108	0.901	0.237	SPARE			
3C NC14-2	1.247	1.057	0.247- 0.2485	12	0.248	1.009	1.001	0.236	19.80	19.80		
3C NC 8-4	1.752	1.562	0.246- 0.248	13	0.247	1.511	0.497	0.239	21.01	21.01		
3C NC12-1	1.459	1.269	0.248- 0.249	14	0.248	1.212	0.798	0.245	20.91	20.91		
3C NC11-3	1.548	1.358	0.246- 0.248	15	0.248	1.309	0.701	0.237	21.26	21.26		
3C NC10-6	1.644	1.454	0.247- 0.249	16	0.248	1.408	0.602	0.234	20.94	20.94		

THERMOCOUPLE (MAT'L No.)				ASSEMBLY (MAT'L No.10C)					WASHER	FINAL ELECTRICAL RESISTANCE			
Serial Number	"L" Length Measured	"M" Length Measured	Diam. Meas.	Hole Number	Diam. Meas.	Depth Meas.	"X"	Shim Thickness	Forward	Reverse	Chromel Leakage	Alumel Leakage	
3C NC15-4	1.161	0.971	0.2475-0.2485	17	0.249	0.907	1.103	0.252	21.38	21.38	∞	∞	
3C NC15-5-1	1.097	0.907	0.2465-0.249	18	0.249	0.845	1.164	0.250	20.95	20.95			
3C NC 5-8	1.947	1.757	0.249-0.248	19	0.248	1.721	0.294	0.224	20.79	20.79			
15C NC 2-7	2.145	1.955	0.2475-0.2485	20	0.248	1.912	0.101	0.230	SPARE				
4C NC 2-6	2.138	1.948	0.245-0.247	21	0.247	1.916	0.096	0.220	21.19	21.19			
3C NC 6-5	1.848	1.658	0.246-0.248	22	0.247	1.616	0.397	0.230	21.25	21.25			
3C NC13-4	1.342	1.152	0.246-0.248	23	0.248	1.111	0.900	0.229	19.37	19.37			
3C NC15-5	1.149	0.959	0.2485-0.2495	24	0.249	0.911	1.101	0.236	18.83	18.83			
3C NC 8-7	1.742	1.552	0.247-0.248	25	0.247	1.516	0.496	0.224	18.85	18.85			
3C NC 4-5	2.044	1.854	0.245-0.249	26	0.248	1.813	0.199	0.229	21.90	21.90			
3C NC11-4	1.546	1.356	0.246-0.247	27	0.247	1.318	0.695	0.226	16.13	16.13			
4C NC10-8	1.641	1.451	0.245-0.247	28	0.247	1.413	0.600	0.226	15.09	15.09			
3C NC12-3	1.445	1.255	0.247-0.248	29	0.248	1.214	0.800	0.227	SPARE				
4C NC 4-9	2.043	1.853	0.247	46	0.249	1.662	0.500	N/A	18.98	18.98			
3C NC 7-1	1.797	1.607	0.247	47	0.249	1.460	0.702	N/A	18.43	18.43			

APPENDIX A  
PHENOLIC NYLON NOSECAP  
DRAWING LIST

<u>Drawing Number</u>	<u>Revision</u>	<u>Title</u>
LX-410115	G	Assembly - Phenolic Nylon Nosecap
LE-410116	A	Substructure
LD-410117	D	Thermocouple Detail Assembly
LD-410118	E	Optical Light Pipe Abl. Sensor Assy.
LD-410119	D	Spring Wire Abl. Sensor Assy.
LC-410120	A	Ablator
LC-410121		Cable Clamp
LB-410122		Drill Jig, Spring Wire Abl. Sensor
LB-410123		Spacer, Spring Wire Abl. Sensor
LB-410124		Retaining Washer
LB-410125		Bond Tensile Test Specimen
LB-410126		Bond Shear Test Specimen
LD-410127	A	Nosecap Supporting Form
LD-410128	D	Arc-Jet Specimen
LC-410129		Plug Bonding Specimen
LD-410271		Plug Density Variation, Arc-Jet Specimen
LD-410272		Constant Plug Density, Arc-Jet Specimen
LB-410274		Thermal Shock Specimen
LB-410275	A	Ablation Sensor, Arc-Jet Specimen
LA-410276	A	Mount, Arc-Jet Specimen
LC-410277		Thermocouple, Arc-Jet Specimen
LC-410278		Systems Test, Arc-Jet Specimen
LC-410279		Spring Wire Abl. Sensor, Arc-Jet Specimen
LB-410309	A	Calorimeter, Arc-Jet Specimen
LB-410310	A	Calorimeter Holder
LB-410314		Calorimeter, Materials Performance Arc Specimen
LB-410317	C	Materials Performance Arc Specimen
LD-410326		Uninstrumented Arc-Jet Specimen
LC-410327	A	Optical Light Pipe Abl. Sensor, Arc-Jet Specimen
LC-410328		Certified Material L/P Test, Arc-Jet Specimen
LC-410331		Plug Recession, Arc-Jet Specimen
LC-410332		Plug Installation, Arc-Jet Specimen
LA-410333		0.020 Diam. Tube Locating Fixture
LC-410334		Thermocouple and Plug Recession Test, Arc-Jet Specimen
LA-410339		Terminal Strip
LB-410372		Hemispherical Arc-Jet Specimen
LC-603899		Temperature Sensor, Wiring Schematic
LC-604108		Ablation Sensor, Nosecap Wiring Diagram



# APPENDIX B

## SUMMARY OF MEASUREMENTS FOR REENTRY E FLIGHT NOSECAP (NO. 2)

CHANNEL NO. 13, 14.5 KC

### NOSECAP ABLATION SENSORS

Switch Position	Sensor Type	Sensor No.	SENSOR LOCATION			Remarks
			"X" In.	$\phi$ Deg.	$\rho$ In.	
1	Cal. Zero	-	-	-	-	
2-3	Cal. Full	-	-	-	-	
4	Cal. Half	-	-	-	-	
5	Cal. Full	-	-	-	-	
6	Cal. Half	-	-	-	-	
7-17-27	Light Pipe	42	.100	45	2.655	
8-18-28	" "	43	.349	135	"	
9-19-29	" "	44	.452	225	"	
10-20-30	" "	45	.247	315	"	
11	Spring Wire	30	.203	45	1.3275	
12	" "	31	.402	135	"	
13	" "	32	.505	225	"	
14	" "	33	.291	315	"	
15	" "	34	.199	15	2.655	
16	" "	35	.095	75	"	
21	" "	36	.895	105	"	
22	" "	37	.747	165	"	
23	" "	38	.148	195	"	
24	" "	39	.504	255	"	
25	" "	40	.398	285	"	
26	" "	41	.297	345	"	

NOTE: (1) "X" dimension is sensor measurement point and includes .010 in. in addition to material thickness for spring wire sensors.  
 (2)  $\phi$  is angular position relative to tower side of yaw axis looking forward.  
 (3)  $\rho$  is radial location relative to thrust axis.

NOSECAP CHROMEL-ALUMEL THERMOCOUPLE

Switch Position	Sensor Type	Sensor No.	SENSOR LOCATION			Remarks
			"X" In.	$\phi$ Deg.	$\rho$ In.	
1	Cal. Zero	-	-	-	-	
2-3	Cal. Full	-	-	-	-	
4	Cal. Half	-	-	-	-	
5	Cal. Full	-	-	-	-	
6	Cal. Half	-	-	-	-	
7-22	Thermocouple	4	.401	90	.885	
8-23	"	6	.602	270	"	
9-24	"	13	.501	180	1.9915	
10-25	"	15	.702	240	"	
11-26	"	17	1.102	300	"	
12-27	"	18	1.206	330	"	
13-28	"	19	.301	0	3.0795	
14-29	"	26	.199	210	"	
15-30	"	12	1.003	150	1.9915	
16	"	21	.100	60	3.0795	
17	"	22	.399	90	"	
18	"	47	.700	187.5	3.43	
19	"	Cal. Ref.	-	-	-	
20	"	-	-	-	-	
21	"	-	-	-	-	

CHANNEL NO. 16, 40 KC

MISCELLANEOUS

Switch Position	Measurement	Sensor Number	Sensor Location			Remarks
			"X" In.	$\phi$ Deg.	$\rho$ In.	
1	Cal. Zero	-	-	-	-	
2-3	Full Scale	-	-	-	-	
4	Half Scale	-	-	-	-	
5	Cal. Full	-	-	-	-	
6	Cal. Half	-	-	-	-	
7	A/B Thermocouple	101	-	180	-	5.50 in. *(aft ring)
8	A/B Thermocouple	102	-	180	-	13.38 in. (center ring)
9	A/B Thermocouple	103	-	180	-	21.78 in. (fwd. ring)
10	A/B Thermocouple	104	-	180	-	24.10 in. (fwd. ring)
11	N/C Thermistor 1	1	1.524	0	0	
12	N/C Thermistor 2	2	1.985	330	3.0795	
13	VSWR Direct Fwd	-	-	-	-	
14	VSWR Direct Rev	-	-	-	-	
15	VSWR Delayed Fwd	-	-	-	-	
16	VSWR Delayed Rev	-	-	-	-	
17	Xmtr. Delay Temp.	Thermistor	1	-	-	T/M Deck
18	Cold Junction 1	"	2	-	-	"
19	Xmtr. Direct Temp.	"	3	-	-	"
20	FAT	"	4	-	-	"
21	T/R Temperature	"	5	-	-	"
22	Cold Junction 3	"	6	-	-	"
23	Direct VSWR Temp.	"	7	-	-	"
24	Delay VSWR Temp.	"	8	-	-	"
25	Cold Junction 2	"	9	-	-	"
26	+300 V Monitor	-	-	-	-	
27	Unstable 28 V	-	-	-	-	
28	Stable 28 V	-	-	-	-	
29-30	Zero	-	-	-	-	

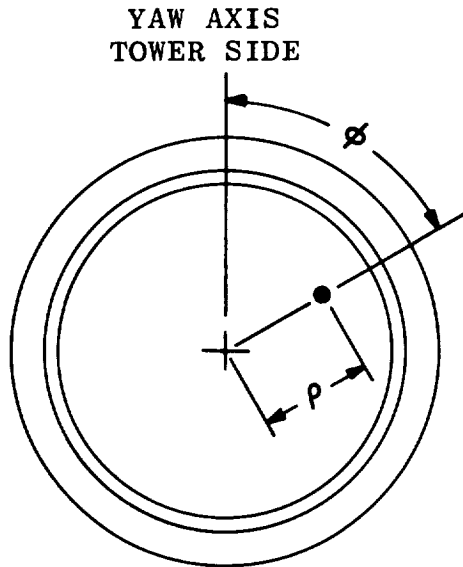
\*Relative to aft end of afterbody

## CHANNEL NO. 18, 70 KC

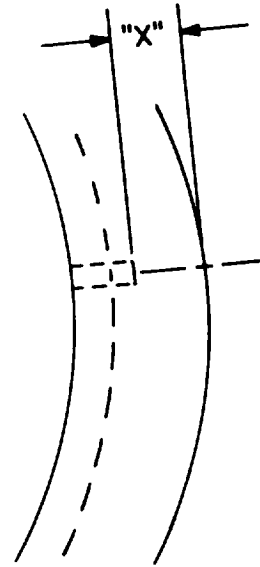
NOSECAP CHROMEL-ALUMEL THERMOCOUPLES

Switch Position	Sensor Type	Sensor No.	Sensor Location			Remarks
			"X" In.	$\phi$ Deg.	$\rho$ In.	
1	Cal. Zero	-	-	-	-	
2-3	Cal. Full	-	-	-	-	
4	Cal. Half	-	-	-	-	
5	Cal. Full	-	-	-	-	
6	Cal. Half	-	-	-	-	
7-22	Thermocouple	3	.302	0	.885	
8-23	"	5	.501	180	"	
9-24	"	7	.299	0	1.9915	
10-25	"	8	.200	30	"	
11-26	"	9	.099	60	"	
12-27	"	10	.400	90	"	
13-28	"	14	.801	210	"	
14-29	"	16	.602	270	"	
15-30	"	23	.902	120	3.0795	
16	"	46	.501	337.5	3.43	
17	"	24	1.205	150	3.0795	
18	"	25	.502	180	"	
19	"	27	.701	240	"	
20	"	28	.601	270	"	
21	"	--				
<u>SPARES</u>						
--	Thermocouple	11	.902	120	1.9915	
--	"	20	.097	30	3.0795	
--	"	29	.801	300	"	





NOSECAP (VIEW LOOKING FWD)



DEFINITIONS:

- $\phi$  IS ANGLE RELATIVE TO TOWER SIDE OF YAW AXIS
- $\rho$  IS RADIAL DISTANCE FROM THRUST AXIS TO THE SENSOR INSTALLATION HOLE
- "X" IS SENSOR MEASUREMENT POINT RELATIVE TO AND PERPENDICULAR TO THE NOSECAP FRONT SURFACE

SUMMARY OF MEASUREMENTS  
FOR BACKUP NOSECAP NO. 1

CHANNEL NO. 13, 14.5 KC

NOSECAP ABLATION SENSORS

Switch Position	Sensor Type	Sensor No.	Sensor Location			Remarks
			"X" In.	$\phi$ Deg.	$\rho$ In.	
1	Cal. Zero	-	-	-	-	
2-3	Cal. Full	-	-	-	-	
4	Cal. Half	-	-	-	-	
5	Cal. Full	-	-	-	-	
6	Cal. Half	-	-	-	-	
7-17-27	Light Pipe	42	.102	45	2.655	
8-18-28	"	43	.352	135	"	
9-19-29	"	44	.451	225	"	
10-20-30	"	45	.250	315	"	
11	Spring Wire	30	.200	45	1.3275	
12	"	31	.402	135	"	
13	"	32	.498	225	"	
14	"	33	.299	315	"	
15	"	34	.199	15	2.655	
16	"	35	1.101	75	"	
21	"	36	.897	105	"	
22	"	37	.099	165	"	
23	"	38	.146	195	"	
24	"	39	.500	255	"	
25	"	40	.398	285	"	
26	"	41	.299	345	"	

NOTE: (1) "X" dimension is sensor measurement point and includes .010 in. in addition to material thickness for spring wire sensors.  
 (2)  $\phi$  is angular position relative to tower side of yaw axis looking forward.  
 (3)  $\rho$  is radial location relative to thrust axis.

CHANNEL NO. 14, 22 KC  
NOSECAP CHROMEL-ALUMEL THERMOCOUPLE

Switch Position	Sensor Type	Sensor No.	Sensor Location			Remarks
			"X" In.	$\phi$ Deg.	$\rho$ In.	
1	Cal. Zero	-	-	-	-	
2-3	Cal. Full	-	-	-	-	
4	Cal. Half	-	-	-	-	
5	Cal. Full	-	-	-	-	
6	Cal. Half	-	-	-	-	
7-22	Thermocouple	4	.301	90	.885	
8-23	"	6	.601	270	"	
9-24	"	13	.497	180	1.9915	
10-25	"	15	.701	240	"	
11-26	"	17	1.103	300	"	
12-27	"	18	1.164	330	"	
13-28	"	19	.294	0	3.0795	
14-29	"	26	.199	210	"	
15-30	"	12	1.001	150	1.9915	
16	"	21	.096	60	3.0795	
17	"	22	.397	90	"	
18	"	47	.702	187.5	3.43	
19	"	Cal. Ref.	-	-	-	
20	"	--	-	-	-	
21	"	--	-	-	-	

MISCELLANEOUS\*

Switch Position	Measurement	Sensor Number	Sensor Location			Remarks
			"X" In.	$\phi$ Deg.	$\rho$ In.	
1	Cal. Zero	-	-	-	-	*Same as for flight nosecap configuration except for nosecap Thermistors 1 and 2
2-3	Full Scale	-	-	-	-	
4	Half Scale	-	-	-	-	
5	Cal. Full	-	-	-	-	
6	Cal. Half	-	-	-	-	
7	A/B Thermocouple	101	-	-	-	
8	A/B Thermocouple	102	-	180	-	
9	A/B Thermocouple	103	-	180	-	
10	A/B Thermocouple	104	-	180	-	
11	N/C Thermistor 1	1	1.539	0	0	
12	N/C Thermistor 2	2	2.018	330	3.0795	
13	VSWR Direct Fwd	-	-	-	-	
14	VSWR Direct Rev	-	-	-	-	
15	VSWR Delayed Fwd	-	-	-	-	
16	VSWR Delayed Rev	-	-	-	-	
17	Xmtr. Delay Temp.	Thermistor 1	-	-	-	T/M Deck
18	Cold Junction 1	" 2	-	-	-	"
19	Xmtr. Direct Temp.	" 3	-	-	-	"
20	FAT	" 4	-	-	-	"
21	T/R Temperature	" 5	-	-	-	"
22	Cold Junction 3	" 6	-	-	-	"
23	Direct VSWR Temp.	" 7	-	-	-	"
24	Delay VSWR Temp.	" 8	-	-	-	"
25	Cold Junction 2	" 9	-	-	-	"
26	+300 V Monitor	-	-	-	-	
27	Unstable 28 V	-	-	-	-	
28	Stable 28 V	-	-	-	-	
29-30	Zero	-	-	-	-	

CHANNEL NO. 18, 70 KC

NOSECAP CHROMEL-ALUMEL THERMOCOUPLES

Switch Position	Sensor Type	Sensor No.	Sensor Location			Remarks
			"X" In.	$\phi$ Deg.	$\rho$ In.	
1	Cal. Zero	-	-	-	-	
2-3	Cal. Full	-	-	-	-	
4	Cal. Half	-	-	-	-	
5	Cal. Full	-	-	-	-	
6	Cal. Half	-	-	-	-	
7-22	Thermocouple	3	.294	0	.885	
8-23	"	5	.495	180	"	
9-24	"	7	.300	0	1.9915	
10-25	"	8	.200	30	"	
11-26	"	9	.099	60	"	
12-27	"	10	.401	90	"	
13-28	"	14	.798	210	"	
14-29	"	16	.602	270	"	
15-30	"	23	.900	120	3.0795	
16	"	46	.500	337.5	3.43	
17	"	24	1.101	150	3.0795	
18	"	25	.496	180	"	
19	"	27	.695	240	"	
20	"	28	.600	270	"	
21	"	--	-	-	-	
<u>SPARES</u>						
--	Thermocouple	11	.901	120	1.9915	
--	"	20	.101	30	3.0795	
--	"	29	.800	300	"	

